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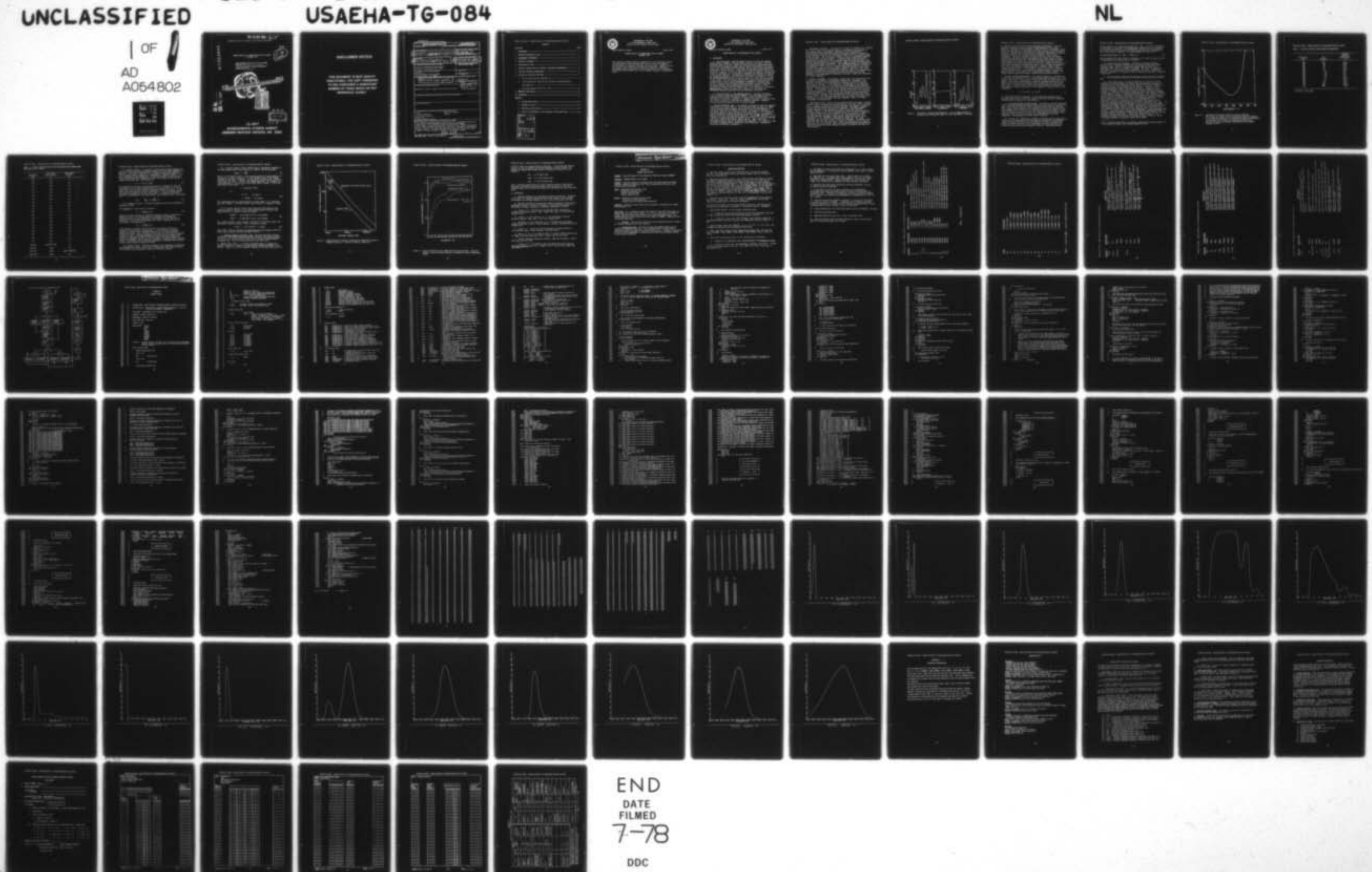

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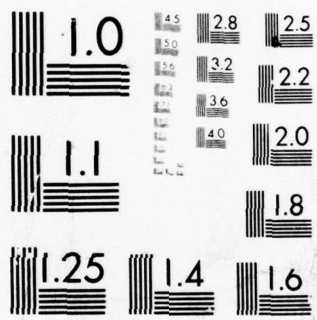

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HAZARD ANALYSIS OF BROAD-BAND OPTICAL SOURCES

DECEMBER 1977

US ARMY
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This technical guide provides an explanation of the techniques used by the Laser Branch, Laser Microwave Division, US Army Environmental Hygiene Agency, to evaluate non-laser optical sources. Hazard criteria and spectral data reduction techniques are explained. Radiometric measurements are not included. The Laser Microwave Division Spectral Weighting Program (LMDSWP--a Fortran V computer program) is presented in detail.

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Technical Guide - Hazard Analysis of Broad-Band Optical Sources

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HAZARD ANALYSIS OF BROAD-BAND OPTICAL SOURCES

1. BACKGROUND.

a. The Laser Branch, Laser Microwave Division, US Army Environmental Hygiene Agency (USAEHA), evaluates hazards from not only lasers, but also broad-band optical sources. Examples of such sources include searchlights, infrared missile guidance systems, optical beacons and hospital ultraviolet lamps. This guide explains the techniques used to reduce spectroradiometric measurements of such sources. To evaluate a broad-band optical source such as an arc, a lamp or an array of lamps as are found in hospital, military and industrial equipment, it is necessary to determine the spectral distribution of the optical radiation. The spectral distribution of interest is that of the accessible emission, which may differ from that of the open arc or lamp due to filtration by a plastic or glass window or by other optical elements in the system. The final hazard analysis of an optical source requires the weighted sum of several spectroradiometric parameters to estimate total retinal irradiance and biologically-weighted corneal and skin irradiance. How these weighted sums are evaluated is explained in detail in "The Evaluation of Optical Radiation Hazards" by D. H. Sliney and B. C. Freasier, Applied Optics, Volume 12, pages 1-24, January 1973 (reference 10d). Ultraviolet radiation exposure limits are provided in AR 40-46.

b. During 1976-1977, a new computer program -- The Laser Microwave Division Spectral Weighting Program (LMDSWP) -- was developed by the Data Processing and Technical Information Services Branch of USAEHA and is explained in this guide in Appendix A. Appendix B provides a program listing and a table of values for the spectral weighting functions. Appendix C provides operating instructions for using the program.

2. REQUIRED RADIOMETRIC DATA. The spectral irradiance E_λ should be complete from 200 nm to at least 1400 nm. For fluorescent lamps and many arc lamps, little infrared radiation beyond 1200 nm exists and can be neglected if instrument capability is limited to 1200 nm. The spectral irradiance E_λ at the nearest point of access (usually at the glass cover) is of interest in assessing potential ultraviolet hazards to the skin and eye, and potential hazards to the skin from the entire spectrum. The spectral radiance L_λ is of interest for assessing potential hazards to the retina and should be complete from 400 to 1400 nm (the retinal hazard region). Again, the actual measurements beyond 1200 nm can generally be neglected. The values of L_λ may be closely estimated from E_λ values and source dimensions. Radiometric quantities are defined in Appendix D.

3. MEASUREMENT TECHNIQUES. The spectrum of an open arc process (e.g., welding arc), an arc lamp, a gas discharge lamp or a fluorescent lamp consists of line structure plus a continuum. Significant errors can be made in representing the spectrum and weighting the spectrum against a biological action spectrum if the fraction of energy in each line is not properly added to the continuum. The first panel of Figure 1 shows a hypothetical spectral recording from a spectroradiometer. If spectral points were arbitrarily recorded every 5 nm, most of the line-peak recordings would be missed. The width of the triangular line at half of the peak is called the band-width of the monochromator/spectroradiometer. The recommended method for representing the spectrum in tabular form is to provide the measured spectral irradiance [$\mu W/(cm^2 \cdot nm)$] of the continuum at regular intervals (typically every 5 nm) and then list separately the irradiance ($\mu W/cm^2$) in each line. The latter values are determined by subtracting the continuum spectral irradiance at the spectral line from the peak reading and multiplying that value by the bandwidth of the monochromater (typically 2 to 5 nm). These line irradiances are listed separately.

4. SPECTRAL HISTOGRAM. For graphical illustrations, the continuum and line structure is recombined by the computer program into a histogram. The spectral divisions of the histogram most accurately present the spectral resolution of the data. If the spectrum is represented in 5-nm intervals, the irradiance of each line is divided by 5 nm and added to the continuum spectral irradiance value in that 5-nm interval in which the emission line is located. As an example, we may wish to represent the spectrum of a mercury arc by having points at 300 nm, 305 nm, 310 nm, 315 nm, etc. The 5-nm band centered at 305 nm (i.e., 302.5 to 307.5 nm) contains the 303-nm emission line of mercury; likewise, the band centered at 315 nm contains the 313-nm emission line. Since the band centered at 310 nm contains no emission line of mercury, it truly represents only the continuum. Panel 3 of Figure 1 illustrates a histogram plot.

5. PROCESSING OF DATA. Many of the calculations which are useful in hazard analysis require weighting the spectrum against a biological action spectrum (e.g., erythema or photokeritititis action spectrum, the photopic response of the eye, and the retinal-injury action spectrum). The LMDSWP computer program (Appendix B) was developed to simplify this data reduction. Normally, there is little error introduced by using the digitized spectral irradiance values used in the histogram plot for this process. However, if the lamp spectrum is changing rapidly at the same location where the weighting spectrum undergoes a rapid change, significant errors can be introduced. It is, therefore, preferable to weight the line values separately when one type of lamp is routinely evaluated. The mercury lines (254, 293, 303, 313, 365, 405, 435 nm, etc.) are found not only in mercury lamps but also in fluorescent lamps. Routine hand-computing techniques and the machine-computing routine separately weight two spectra and then add them afterward.

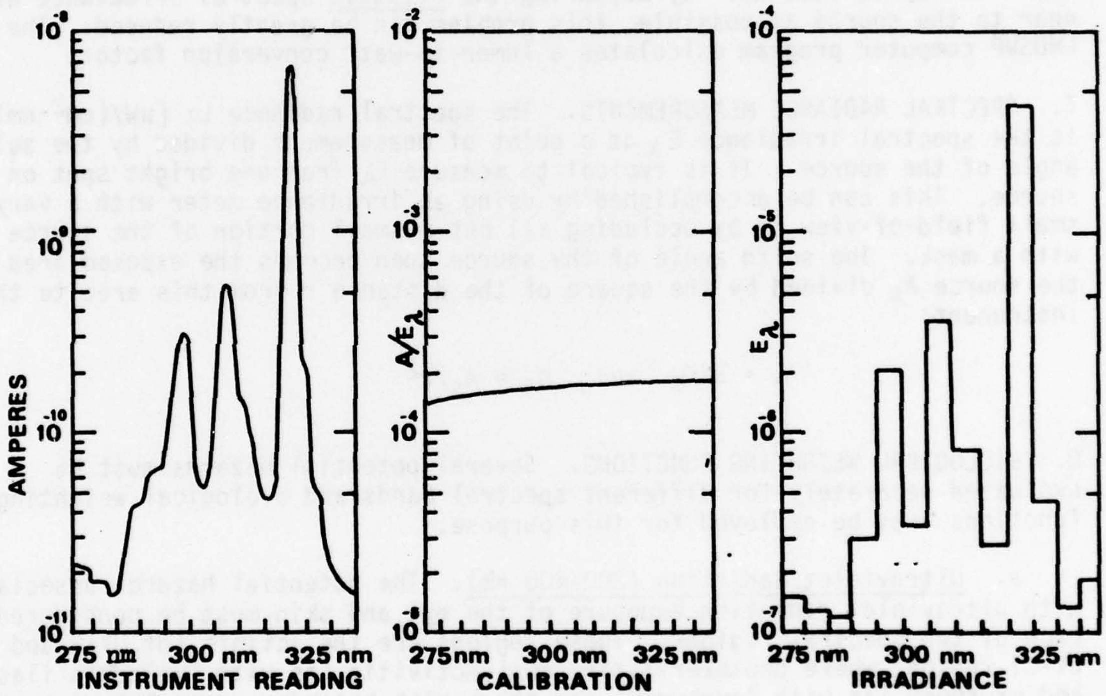

Figure 1. Hypothetical Spectral Data Reduction. The instrument reading is divided by the calibration factor to yield the spectral irradiance.

6. ABSOLUTE VERSUS RELATIVE SPECTRAL IRRADIANCE MEASUREMENTS. Absolute spectral irradiance or spectral radiance measurements are not always essential. Photometric-to-radiometric conversion factors (lumen/watt ratios) can be obtained from a relative spectrum of the lamp taken at any accessible location. Provided that a luminance and illuminance measurement are made at a point of interest, the absolute spectroradiometric values can be calculated. This latter approach is often preferable since illuminance (lm/cm^2) and luminance (cd/cm^2) measurements can be made rapidly at many accessible points of interest. Provided that the spectrum does not change from one point to another, the ultraviolet-radiation hazard and retinal-injury hazard can be calculated at all such points. Because of the limits of sensitivity introduced by photocathode noise in typical spectroradiometers, it is often not possible to obtain spectral irradiance values at some distance from the source. This problem is particularly acute in the near infrared beyond 1000 nm. By measuring the relative spectral irradiance as near to the source as possible, this problem can be greatly reduced. The LMDSWP computer program calculates a lumen-to-watt conversion factor.

7. SPECTRAL RADIANCE MEASUREMENTS. The spectral radiance L_λ [$\mu W/(cm^2 \cdot nm)$] is the spectral irradiance E_λ at a point of measurement divided by the solid angle of the source. It is typical to measure E_λ from one bright spot on the source. This can be accomplished by using an irradiance meter with a very small field-of-view or by occluding all but a small portion of the source with a mask. The solid angle of the source then becomes the exposed area of the source A_s divided by the square of the distance r from this area to the instrument:

$$L = E/\Omega_s \quad \text{and} \quad \Omega_s = A_s/r^2 \tag{1}$$

8. BIOLOGICAL WEIGHTING FUNCTIONS. Several potential hazards must be evaluated separately for different spectral bands and biological weighting functions must be employed for this purpose.

a. Ultraviolet Radiation (200-400 nm). The potential hazards associated with ultraviolet radiation exposure of the eye and skin must be considered in each of two spectral regions. These regions are the actinic (or UV-B and UV-C) region, where photokerititis, conjunctivitis (as with "welder's flash") and erythema (as with "sunburn") are the health hazards associated with this form of radiation exposure; and the near ultraviolet (UV-A) spectral region, where the effects are not well known, but cataractogenesis has been suggested. Cataractogenesis may also result from UV-B.

(1) Actinic UV. Standards for exposure to the eye and skin developed at USAEHA and now recommended by both the American Conference of Governmental Industrial Hygienists (ACGIH) and the National Institute of Occupational Safety and Health (NIOSH) of the US Department of Health, Education, and Welfare have generally become accepted in the USA -- particularly where

ocular exposure is of concern (references 10a - 10c). The limit for exposure is based upon an "envelope" action spectrum for photokeritits and erythema. The spectrum from the source at the nearest accessible point is weighted by this curve (Figure 2 and Table 1) for wavelengths less than 318 nm.

The weighting formula is: $E_{eff} = \sum E_\lambda \cdot S_\lambda \cdot \Delta\lambda$ (2)

and the permissible 8-hour limit for exposure is 10^{-7} W/cm^2 for E_{eff} (a total corresponding to an exposure dose of 3 mJ/cm^2).

(2) Near-Ultraviolet Radiation. Criteria for limiting personnel exposure to UV-A radiation (320-400 nm) are presently based upon limited biological data. The solar irradiance incident upon the skin of an individual out-of-doors is normally 1-4 mW/cm^2. The level of 1 mW/cm^2 is often used as a safe exposure limit (references 10a - 10d). Summing the spectral irradiance, E_λ, from 320 to 400 nm, one obtains the total irradiance in the UV-A.

b. Visible Radiation (400-770 nm) and Near-Infrared Radiation (770-1400 nm).

(1) Blue Light Hazard. The exact boundaries for light (or "visible radiation") are often argued; at present, the International Commission on Illumination (CIE) sets 380-400 nm to 760-780 nm as "visible." However, of principal interest in most USAEHA special studies, is the effect of all radiations from 400 to 1400 nm that reach the retina. Except for small children and aphakics (those with the crystalline lens removed by cataract surgery), so little UV-A radiation reaches the retina that retinal exposure in that spectral region is considered insignificant. Until recently, retinal injury from high-intensity light sources was thought to be thermal injury to retinal tissue. In the past few years, it has become increasingly evident that a photic effect which has as its basis a photochemical (e.g., phototoxic) reaction is responsible for threshold light-induced retinal injury for exposure durations exceeding 10 seconds (references 10d - 10g). The blue-light wavelengths near 440 nm appear to be by far the most hazardous. Although laser safety standards reflect a photochemical injury hypothesis for light exposures greater than 10 seconds, they were initially based on very little data available at the time of their development -- 1973 (references 10d and 10h). For the purpose of evaluating noncoherent, broad-band sources, it is more reasonable to develop a standard for lamp exposures directly from the threshold retinal injury data. A blue-light hazard function, B_λ, was developed at USAEHA from the data of Ham and is given in Table 2. It has since been proposed as a possible future TLV® by ACGIH.

® TLV - Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1977.

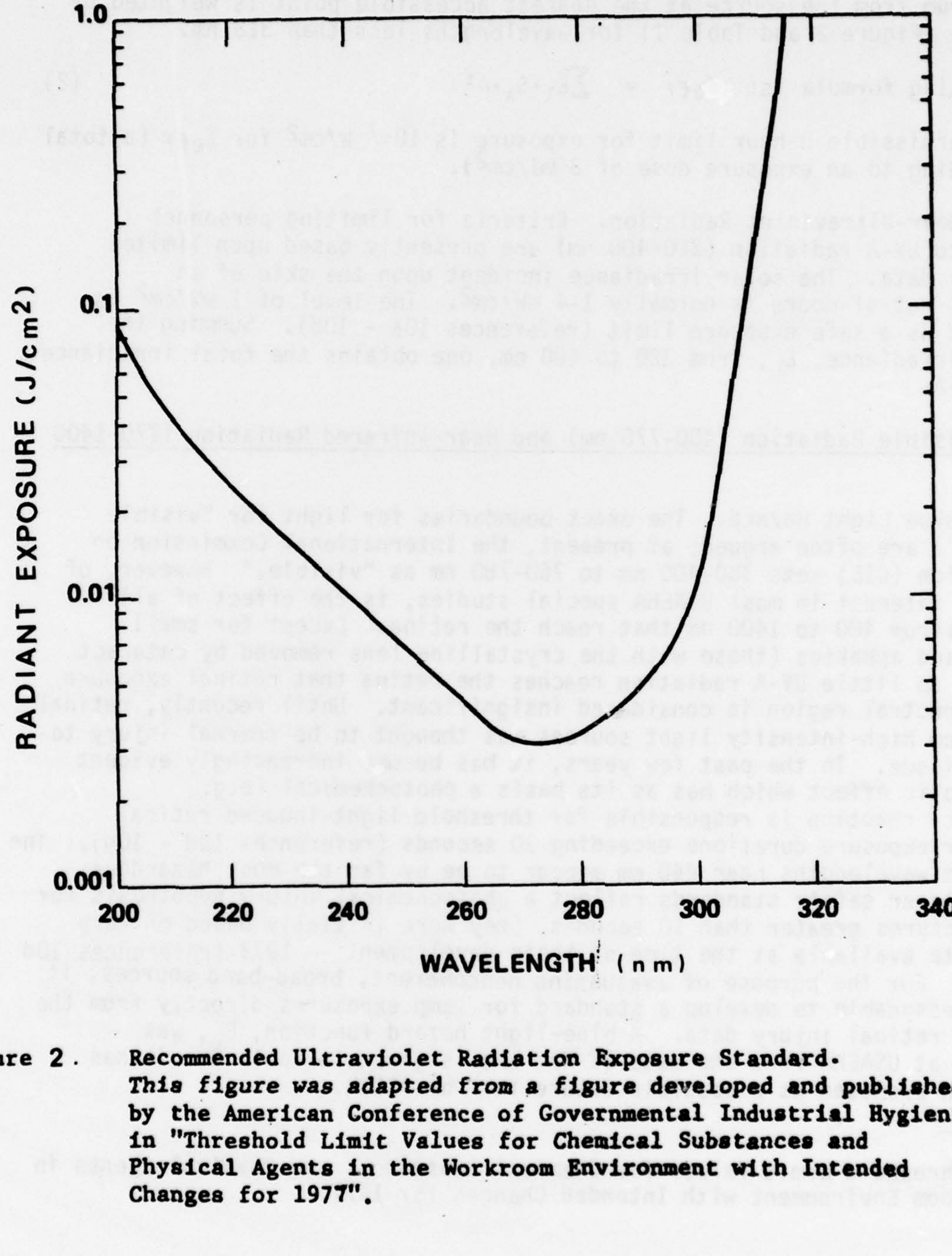

Figure 2. Recommended Ultraviolet Radiation Exposure Standard. ***This figure was adapted from a figure developed and published by the American Conference of Governmental Industrial Hygienists in "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1977".***

TABLE 1. RELATIVE SPECTRAL EFFECTIVENESS BY WAVELENGTH

Wavelength (nm)	TLV (mJ/cm^2)*	Relative Spectral Effectiveness S_λ
200	100	0.03
210	40	0.075
220	25	0.12
230	16	0.19
240	10	0.30
250	7.0	0.43
254	6.0	0.5
260	4.6	0.65
270	3.0	1.0
280	3.4	0.88
290	4.7	0.64
300	10	0.30
305	50	0.06
310	200	0.015
315	1000	0.003

* 1 mJ/cm^2 = 10^{-3} J/cm^2

TABLE 2. SPECTRAL WEIGHING FUNCTIONS FOR ASSESSING RETINAL HAZARDS FROM BROAD-BAND OPTICAL SOURCES

Wavelength (nm)	Blue-Light Hazard Function B_λ	Burn Hazard Function R_λ
400	0.10	1.0
405	0.20	2.0
410	0.40	4.0
415	0.80	8.0
420	0.90	9.0
425	0.95	9.5
430	0.98	9.8
435	1.0	10.0
440	1.0	10.0
445	0.97	9.7
450	0.94	9.4
455	0.90	9.0
460	0.80	8.0
465	0.70	7.0
470	0.62	6.2
475	0.55	5.5
480	0.45	4.5
485	0.40	4.0
490	0.22	2.2
495	0.16	1.6
500-600	$10^{[(450-\lambda)/50]}$	1.0
600-700	0.001	1.0
700-1060	0.001	$10^{[(\lambda-700)/515]}$
1060-1400	0.001	0.2

(2) Retinal Exposure. To consider a retinal injury safety standard, we must first define the relation between retinal levels and lamp brightness (or radiance). The retinal irradiance E_r is related to the source radiance L_s that is being directly viewed and is independent of viewing distance. It is also influenced by the transmission τ of the ocular media in front of the retina and upon the pupil diameter d_e, which for a bright visible source is normally less than 3 mm. The relation is:

$$E_r = 0.27\, L_s \cdot \tau \cdot d_e^2 \tag{3}$$

This equation may be used to calculate the retinal irradiance at just one wavelength or in a narrow wavelength band (e.g., blue light), or it may be used to calculate the total retinal irradiance from 400 to 1400 nm. In the latter case, the spectral radiance distribution L_λ must be weighted against the spectral transmittance of the ocular media τ_λ to obtain an average or effective transmittance of the ocular media, τ_{eff} (reference 10h). The formula is:

$$\tau_{eff} = \sum L_\lambda \cdot \tau_\lambda \cdot \Delta\lambda \Big/ \sum L_\lambda \cdot \Delta\lambda \tag{4}$$

(3) Photometric Values. The source brightness can also be considered in photometric terms.

The luminance L_v of the source is found by:

$$L_v = 683 \sum V_\lambda \cdot L_\lambda \cdot \Delta\lambda \tag{5}$$

Using this formula and the CIE luminous efficiency function V_λ which has a maximal value of 1.0 at 550 nm where the radiometric-to-photometric conversion factor is 683 lumens/watts, from formula (5) the luminance is calculated. Following the same approach for total illuminance E_v at the point where E_λ was measured is:

$$E_v = 683 \sum V_\lambda \cdot E_\lambda \cdot \Delta\lambda \tag{6}$$

These formulae also permit one to calculate the luminous efficacy of radiation from the lamps in lumens/watt. If the spectrum is weighted against the scotopic (rod) response functions V_λ', we then obtain the scotopic efficiency, where the maximal value would be 1.0 at 500 nm (the peak response of rods). Although photometric quantities are not normally used solely for comprehensive hazard evaluation, many relatively inexpensive measuring instruments may be used as a crosscheck on radiometrically measured values. Furthermore, cosine-corrected photometric instruments may be used to cosine-correct spectrally measured UV data.

(4) Exposure Limits. Simplified standard limits developed at USAEHA and also proposed as a future TLV by ACGIH for broad-band light sources provide the following limits expressed in terms of the source radiance.

(a) To protect against retinal thermal injury, the spectral radiance of the lamp weighted against the function R_λ (Table 2) should not exceed:

$$L(HAZ) = \sqrt[4]{t}/\alpha \tag{7}$$

where L is in $W/(cm^2 \cdot sr)$ and t is the viewing duration (or pulse duration if the source is pulsed) limited to 1 μs to 10 seconds, and α is the angular subtense of the source in radians. If the source is oblong (e.g., a tubular flash lamp), the angle refers to the longest dimension. For instance, at a viewing distance r = 100 cm from a xenon flash lamp of length ℓ = 50 cm the approximate viewing angle is:

$$\alpha = 2[\arctan(\ell/2r)]$$

or:

$$\alpha \cong \ell/r \quad \text{for small } \alpha$$

$$\cong 50/100 = 0.5 \text{ radian} \tag{8}$$

This relationship may also be expressed in retinal terms; i.e., irradiance and image diameter. The USAEHA retinal hazard function is graphed in Figure 3.

(b) To protect against retinal injury from blue-light exposure, the integrated spectral radiance of the lamp weighted against the blue-light hazard function B_λ (Table 2) should not exceed:

$$L_p(HAZ) = 100 \ J/(cm^2 \cdot sr) \text{ for } t < 10^4 \text{ seconds}$$

$$L(HAZ) = 10 \ mW/(cm^2 \cdot sr) \text{ for } t > 10^4 \text{ seconds} \tag{9}$$

For a source radiance L which exceeds 2 $mW/(cm^2 \cdot sr)$ in the blue region, the permissible exposure duration t (max) in seconds is simply:

$$t\,(max) = 100 \ J/(cm^2 \cdot sr) \ / \ L\,(blue) \tag{10}$$

These latter limits are greater than maximum permissible exposure limits for 440-nm laser radiation (AR 40-46 and ANSI Z-136.1).

c. Infrared Exposure (770 nm to 1 mm). The total accessible average irradiance in the infrared from most sources should be kept below 10 mW/cm^2. This value is to protect against either retinal injury or cataractogenesis (reference 10d). The IR-A radiance should be less than $0.6/\alpha$.

9. AMBIENT LIGHT LEVELS. It is often considered useful to compare the spectral radiance of a lamp to the same spectral radiance of natural light sources. Figure 4 is a plot of spectral radiance of the solar disc (Ω_s = 6.9

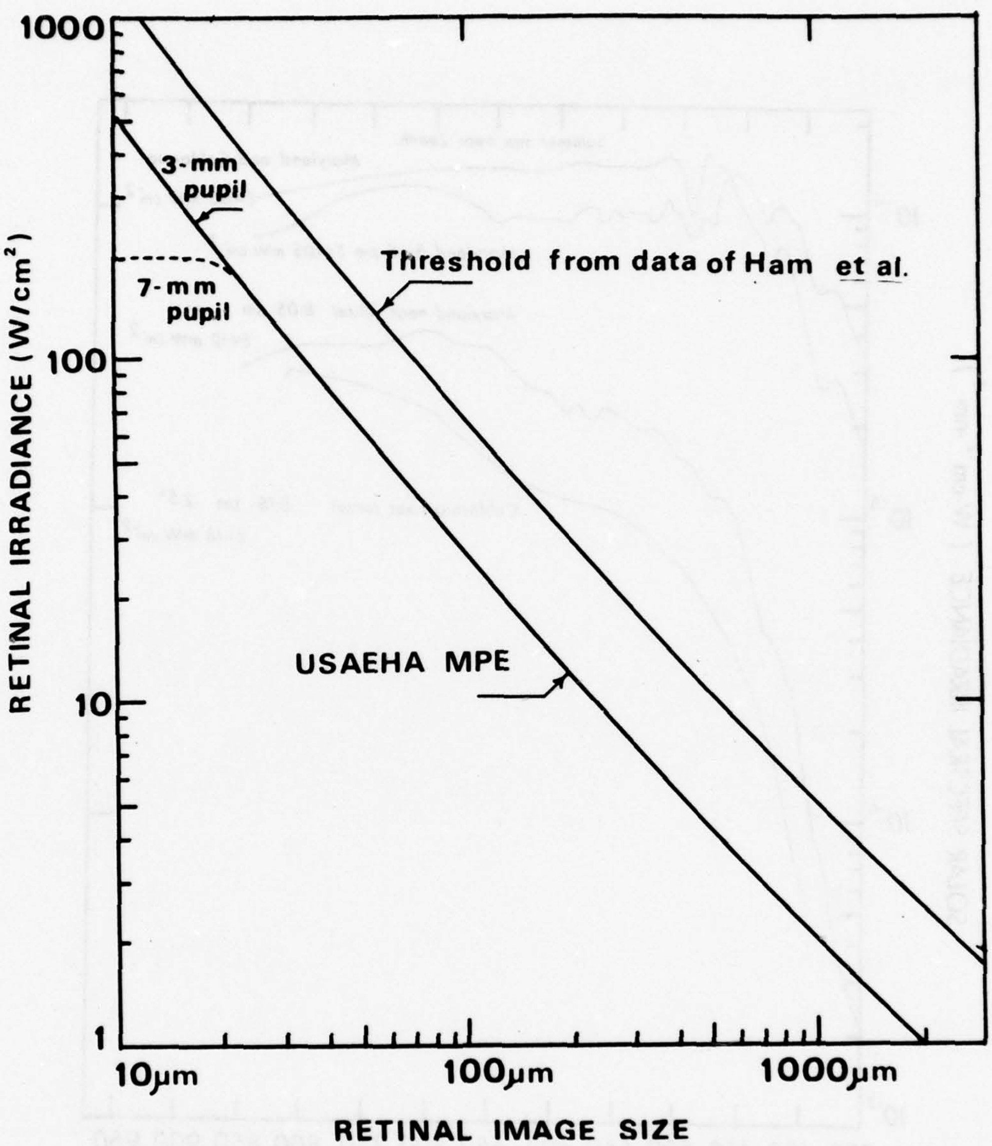

Figure 3. USAEHA Permissible Retinal Irradiance for Momentary Viewing of Extended Sources as a Function of Retinal Image Size.

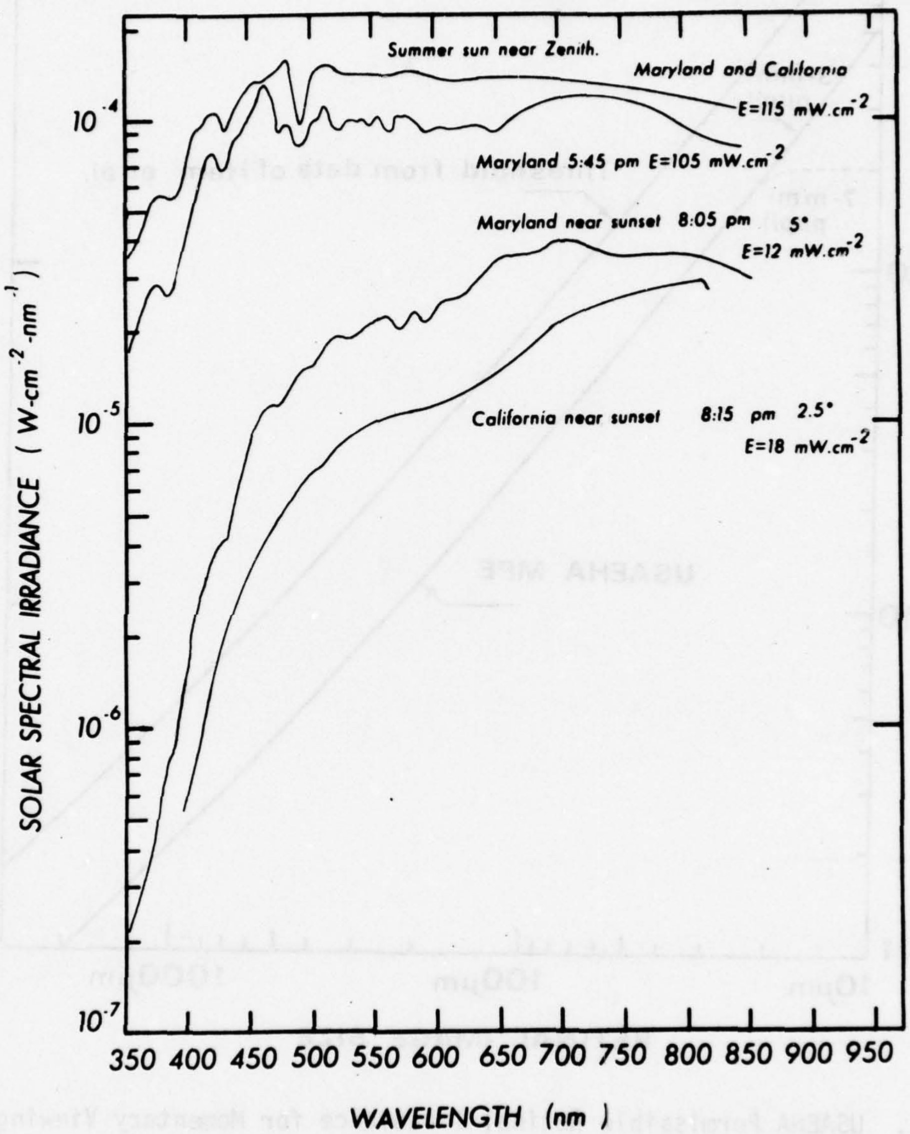

Figure 4. Spectral Radiance of the Summer Sun for Two Localities. Note the change in short-wavelength spectral irradiance as the sun approaches sunset.

x $10^{-5}\cdot$sr) and of an average blue-sky condition. To calculate the spectral radiance of snow at noonday, divide the uppermost curves by 50,000. For example, the approximate noonday spectral radiances at 440 nm are (from Figure 4):

Sun: 1.3 W/($cm^2\cdot$sr$\cdot$nm)

Snow: 2.6 x 10^{-5} W/(cm$\cdot$sr$\cdot$nm)

Sky: 7 x 10^{-6} W/($cm^2\cdot$sr$\cdot$nm)

Until a thorough understanding of chronic exposure hazards to the eye has developed, one should be concerned about ocular exposures to the levels exceeding those of the latter two sources for long periods of time (reference 10i).

10. REFERENCES.

a. American Conference of Govermental Industrial Hygienists, "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1977," ACGIH, Cincinnati, OH (1977)

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Technical Guide - Hazard Analysis of Broad-Band Optical Sources

APPENDIX A

PROGRAM DESCRIPTION

PROGRAM: Laser Microwave Division Spectral Weighting Program (LMDSWP)

LANGUAGE: FORTRAN (EXEC 8 run stream)

PURPOSE: Calculate spectral irradiance data from uncorrected instrument readings, weight by biological and filter transmittance functions, and produce tables and graphs.

INPUT: Description and control cards
Weighting functions data
General function data
Source spectral data

OUTPUT: Print-out of certain input values
Print-out of calculated data
Calcomp plots of certain calculated data

SEQUENCE: Each set of data cards must be ordered in ascending wave length (card columns 1-4)

INPUT DATA: For a column-by-column description of the input data cards see coding forms and card layout sheets. Of critical importance to LMDSWP is proper ordering of data values according to associated wavelength. The FORTRAN name and printer heading for wave length is LAMBDA. Comments follow concerning input data.

a. Biodeck. The unitless functions of wave length set forth in Table 1 are seldom changed and are used routinely.

b. Calibration Data: For each of seven instruments there are two 'spectral calibration functions', one associated with a visible light calibration source and one with an ultraviolet source. A spectral calibration value at a given wavelength is computed by dividing the instrument reading by the source irradiance.

PROGRAM DESCRIPTION

1. Read two 'project description' cards for use in the printer output heading. The cards should contain the project number, date of initiation, and a brief description.

2. Read the 'calculation control' card, which contains the number of filters considered (FORTRAN name NUMFIL may take on values 0,1,or 2), the form of the filter transmission functions in terms of the number of data fields to be read per filter (FORTRAN NOCOFT = 1 for precalculated, 2 for raw data pairs), the form of the calibration data to be read (integer CALDAT =0 for raw data pairs, 1 for precalculated, 2 for program to generate '1.0' for all wavelengths), the weighting calculation to be performed (integer GENWEI = 00-15; see Table 2), whether a general function is tobe read(integer GENFUN = 1) or the program-initialized function of 'one' for all wavelengths is to be used (GENFUN = 0).

3. Read the fourth 'distance factor' card for adjustment of source data by the inverse - square law. There is a factor (FORTRAN DFU) for UV wavelenths and another (DFV) for visible wavelengths.

The first four control cards must be present in each run. The data yet to be described are optional, and depend on 'calculation control' parameters.

4. Read (unless CALDAT =2) and process calibration data.

a. If data are precalculated, multiply by DFU for wavelengths less than or equal to 300 nm or by DFV for wavelengths greater than 300.

b. If data are in raw form, read dividends, then divisors; check for wavelength matches; perform divisions; and incorporate distance factors as in (a).

5. Read biological data deck (BIODEK): S-, U-, V-, V*-, T-, T-A-, C-A-, and A-LAMBDA are separated into wavelength-paired arrays.

6. Read, also into paired arrays, remaining biological data, one set at a time: B-LAMBDA, X-BAR LAMBDA, Y-BAR LAMBDA, Z-BAR LAMBDA, P-445, P-535, and P-575.

7. Read filter transmission data, if any, and process if necessary.

a. If data are in precomputed form, read wavelength and transmission values.

b. If data are in raw form, read wavelength, dividend, and divisor. Perform division and store result as in (a). For a two-filter case, filter two is considered first.

8. The general function array FOFX was initialized to all 'ones' at the program beginning. If calculation control GENFUN=1, read general function data into FOFX.

9. Read data for the source under study: name of event, solid angle, and spectral data. Disregard data with wavelength less than the largest previously read-wavelength. Negate wavelengths of cards punched with 'PEAK'; this distinction is necessary for the following calculation.

10. Determine the DELTA value associated with each wavelength, for use in various spectral weightings.

11. A wavelength interval for source readings (or intermediately-calculated values) may not exactly match an interval for biological or calibration data. Therefore, in weighting calculations subroutine INTERP may be called to use source deck wavelengths for interpolation of 'bio' or 'cal' values.

12. Perform calculations to obtain: $E_i$fofx(λ); E_λ;L_λ;$E_\lambda \cdot F_\lambda(1)$,$E_\lambda \cdot F_\lambda(2)$, or $E_\lambda \cdot F_\lambda(1,2)$; $E_r(\lambda)$; G-LAMBDA; integrated sums of source irradiance multiplied spectrally by filter and bio functions; and percentages of total irradiance which are UV, visible, or near -IR radiation.

13. Create Calcomp plot file containing header record, wavelengths, and data.

14. Print the calculated data.

15. Read and process the next set, if any, of spectral data.

16. After all spectral sets have been processed, create a Calcomp plot tape for histogram presentation of output.

FUNCTION	FORTRAN NAME	PRINTER HEADING	DESCRIPTION
S_λ	SLAMBD	S-LAMBDA	ACGIH UV hazard envelope function
U_λ	ULAMBD	U-LAMBDA	1936 CIE UV skin erythema action spectrum
Λ_λ	ALAMBD	A-LAMBDA	ANSI Z136 laser weighting - UV hazard function
T_λ	TLAMBD	T-LAMBDA	Ocular media transmission
$T_\lambda \cdot A_{PE\lambda}$	TALAMB	T-A-LAMBDA	Absorption in the retina
$1/C_A$	CALAMB	C-A-LAMBDA	Reciprocal of ANSI near-IR retinal burn correction factor
V_λ	VLAMBD	V-LAMBDA	CIE-1970 photopic visibility function
V'_λ	VPLAMB	V*-LAMBDA	CIE-1970 scotopic visibility function
B_λ	BLAMBD	B-LAMBDA	ACGIH blue-light hazard function
$\bar{X}_\lambda$	XBLAMB	X-BAR LAMBDA	CIE-1931 blue chromaticity coordinate
$\bar{Y}_\lambda$	YBLAMB	Y-BAR LAMBDA	CIE-1931 green chromaticity coordinate
$\bar{Z}_\lambda$	ZBLAMB	Z-BAR LAMBDA	CIE-1931 red chromaticity coordinate
P_{445}	P445LB	P-445	Dartnall nomogram absorption coefficient for blue
P_{535}	P535LB	P-535	Dartnall nomogram absorption coefficient for green
P_{575}	P575LB	P-575	Dartnall nomogram absorption coefficient for red

TABLE 1. **Biodeck Data**

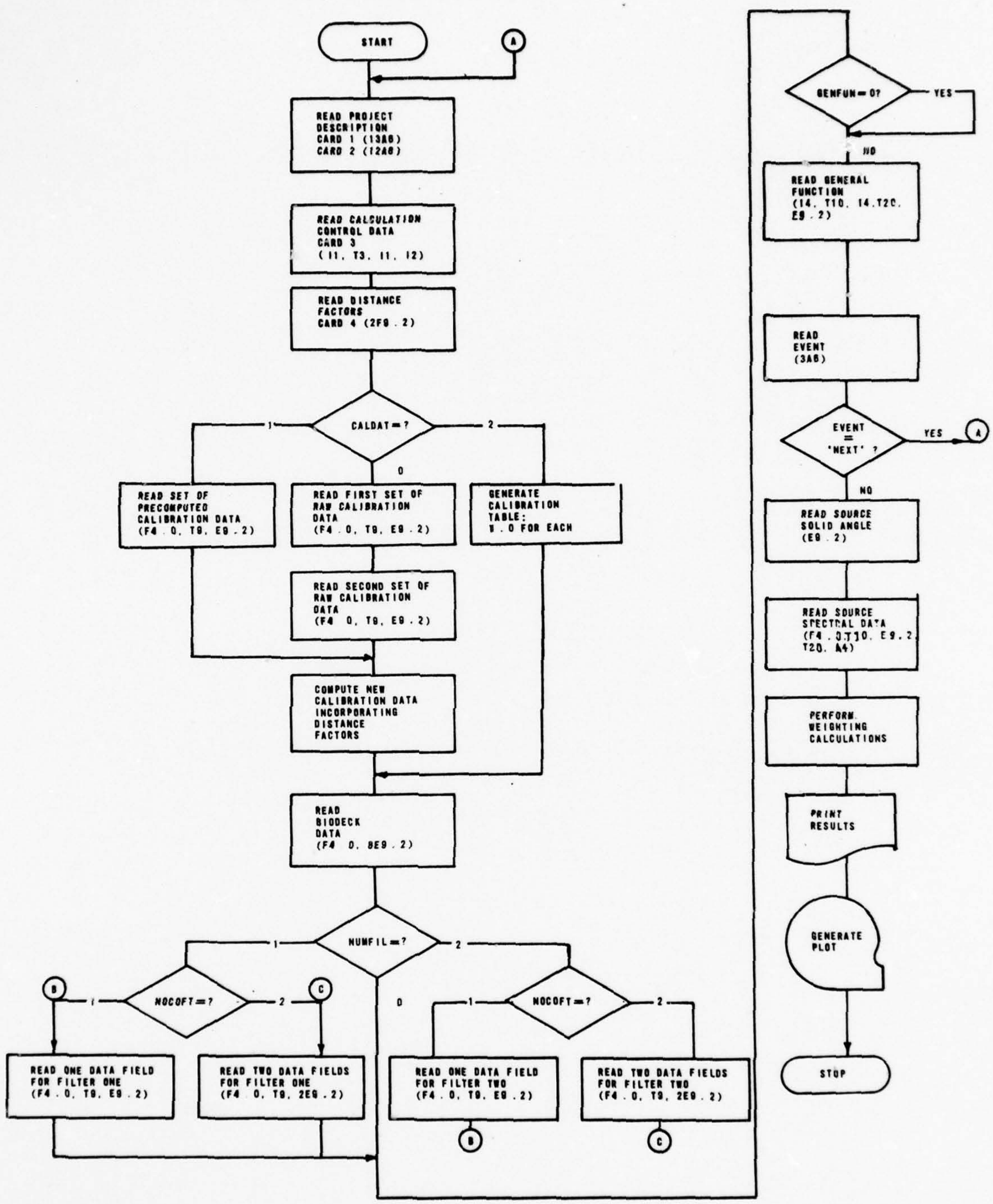
CODE	CALCULATION
00	No calculation
01	E-LAMBDA * S- LAMBDA
02	E-LAMBDA * U-LAMBDA
03	E-LAMBDA * A-LAMBDA
04	E-LAMBDA * T-LAMBDA
05	E-LAMBDA * T-A-LAMBDA
06	E-LAMBDA * C-A-LAMBDA
07	E-LAMBDA * V-LAMBDA
08	E-LAMBDA * V*-LAMBDA
09	E-LAMBDA * B-LAMBDA
10	E-LAMBDA * X-BAR LAMBDA
11	E-LAMBDA * Y-BAR LAMBDA
12	E-LAMBDA * Z-BAR LAMBDA
13	E-LAMBDA * P-445
14	E-LAMBDA * P-535
15	E-LAMBDA * P-575

TABLE 2. Values of GENWEI - General Weighting Calculations.

FUNCTION	FORTRAN NAME	DESCRIPTION
V/E_e	VE	Radiant efficacy of radiation from λ min to λ max in lumens/watt: equals $(\sum_{\lambda} 680\ E_{\lambda} V_{\lambda} \Delta\lambda)\ E_e$
V'/E_e	VIE	Fraction CIE scotopic radiation from λ min to λ max; equals $(\sum_{\lambda} E_{\lambda} V'_{\lambda} \Delta\lambda)/E_e$
$\sum E^T/E_e$	TRANS	Effective transmission of ocular media from λ min to λ max; equals $(\sum_{\lambda} E_{\lambda} T_{\lambda} \Delta\lambda)/E_e$
	TRANTX	Effective transmission of ocular media multiplied by spectral absorption of ocular media; equals $(\sum_{\lambda} E_{\lambda} T_{\lambda} A_{rel} \Delta\lambda)/E_e$
E_e/C_A	EECA	ANSI laser MPE weighting factor for visible and IR-A; equals $(\sum_{\lambda} E_{\lambda}/C_{A\lambda} \Delta\lambda)/E_e$
	PCTUV	Percent of total irradiance between λ min and λ max which is UV radiation; equals $(100 \sum_{\lambda_{min}}^{400} E_{\lambda} \Delta\lambda)/E_e$
	PCTVI	Percent of total irradiance which is visible radiation; equals $(100 \sum_{400}^{760} E_{\lambda} \Delta\lambda)/E_e$
	PCTNIR	Percent of total irradiance which is near -IR radiation; equals $(100 \sum_{760}^{\lambda_{max}} E_{\lambda} \Delta\lambda)/E_e$

FUNCTION	FORTRAN NAME	DESCRIPTION
B_λ	BLUHAZ	Blue light hazard function weighted against spectral irradiance; equals $\sum_\lambda E_\lambda B_\lambda \Delta\lambda$
$\bar{x}_\lambda$	XBAR	CIE-1931 blue chromaticity coordinate weighted against spectral irradiance; equals $\sum_\lambda E_\lambda \bar{x}_\lambda \Delta\lambda$
$\bar{y}_\lambda$	YBAR	CIE-1931 green chromaticity coordinate weighted against spectral irradiance; equals $\sum_\lambda E_\lambda \bar{y}_\lambda \Delta\lambda$
$\bar{z}_\lambda$	ZBAR	CIE-1931 red chromaticity coordinate weighted against spectral irradiance; equals $\sum_\lambda E_\lambda \bar{z}_\lambda \Delta\lambda$
P-445	P445LB	Dartnall nomogram absorption coefficient for blue weighted against spectral irradiance
P-535	P535LB	Dartnall nomogram absorption coefficient for green weighted against spectral irradiance
P-575	P575LB	Dartnall nomogram absorption coefficient for red weighted against spectral irradiance.

FUNCTION	FORTRAN NAME	DESCRIPTION
CF_λ	CF	Calibration factor; equals (R_{vis}/E_{viscal})(DFV) for 250-1400 nm or 300-1400 nm; equals (R_{uv}/E_{uvcal})(DFU) for 200-300 nm
E_i	EINSTR	Instrument readings for corroboration of input data in amperes.
$E_i(fcfx(\lambda))$	EIFOFX	Adjusted instrument readings; equals $E_i(fcfx(\lambda))$
E_λ	ELAMBD	Spectral irradiance of source under study; equals $E_i(fcfx(\lambda))/CF_\lambda$
L_λ	LLAMBD	Spectral radiance of source under study; equals E_λ/Ω
$E_\lambda \cdot F_\lambda(1)$	EFT	Spectral filter transmission for filter one; equals $(E_\lambda)(FT1)$
$E_\lambda \cdot F_\lambda(2)$	EFT	Spectral filter transmission for filter two; equals $(E_\lambda)(FT2)$
$E_\lambda \cdot F_\lambda(1,2)$	EFT	Spectral filter transmission for filter one and two together; equals $E_\lambda(FT1)(FT2)$
$E_r(\lambda)$	ERETLB	Spectral retinal irradiance for 3-mm and 7-mm pupil; equals 0.27 $(L_\lambda \cdot T_\lambda \cdot D_p^2)$
$X_\lambda \cdot E_\lambda$	GLAMBD	General weighting column; ability to choose any previous function X_λ in biodeck; equals $X_\lambda \cdot E_\lambda$


START
A
READ PROJECT DESCRIPTION CARD 1 (13A6) CARD 2 (12A6)
READ CALCULATION CONTROL DATA CARD 3 (I1, T3, I1, I2)
READ DISTANCE FACTORS CARD 4 (2F9.2)
CALDAT = ?
1
0
2
READ SET OF PRECOMPUTED CALIBRATION DATA (F4.0, T9, E9.2)
READ FIRST SET OF RAW CALIBRATION DATA (F4.0, T9, E9.2)
GENERATE CALIBRATION TABLE; 1.0 FOR EACH
READ SECOND SET OF RAW CALIBRATION DATA (F4.0, T9, E9.2)
COMPUTE NEW CALIBRATION DATA INCORPORATING DISTANCE FACTORS
READ BIODECK DATA (F4.0, 8E9.2)
NUMFIL = ?
1
2
0
B
NOCOFT = ?
1
2
C
NOCOFT = ?
1
2
READ ONE DATA FIELD FOR FILTER ONE (F4.0, T9, E9.2)
READ TWO DATA FIELDS FOR FILTER ONE (F4.0, T9, 2E9.2)
READ ONE DATA FIELD FOR FILTER TWO (F4.0, T9, E9.2)
READ TWO DATA FIELDS FOR FILTER TWO (F4.0, T9, 2E9.2)
B
C
GENFUN = 0?
YES
NO
READ GENERAL FUNCTION (I4, T10, I4, T20, E9.2)
READ EVENT (3A6)
EVENT = 'NEXT' ?
YES
A
NO
READ SOURCE SOLID ANGLE (E9.2)
READ SOURCE SPECTRAL DATA (F4.0, T10, E9.2, T20, A4)
PERFORM WEIGHTING CALCULATIONS
PRINT RESULTS
GENERATE PLOT
STOP

APPENDIX B

COMPUTER LISTING

```
C
C     PROGRAM NAME  LASER MICROWAVE DIVISION SPECTRAL WEIGHTING PROGRAM
C
C     JUSTIFICATION   REQUESTED BY LASER MICROWAVE DIVISION  2 JAN 1976
C                     BY DIV CHIEF ROBERT T. WANGEMANN
C
C     JOB NUMBER  UNASSIGNED AS OF 30 JUNE 1976
C
C     COMPUTER  UNIVAC 1108-EXEC 8
C
C     PROGRAMMER  ROBERT LEE SCHMITT
C
C     DATE COMPLETED  JUNE 1976
C
C     CHANGES  NONE
C
C     SUBROUTINES   INITIL
C                   INTERP
C                   SUM
C                   SUM1
C                   GLAMCO
C                   FILSUM
C                   SEQUEN
C                   PRTCON
C                   HEADIN
C                   BDREAD
C                   HPLOT
C
C     ABSTRACT   PROGRAM REDUCES SPECTRAL DATA TAKEN FROM VARIOUS BROADBAND
C                OPTICAL SOURCES PRODUCING TABLES OF PERTINENT INFORMATION
C                AND PLOT GRAPHS.
C
C     INPUT RECORD LAYOUT
C
C        SOURCE DESCRIPTION CARD
C
C        ONE OF TWO
C
C      1-78            DESCRIPTION
C
C        TWO OF TWO
C
C      1-72            DESCRIPTION
C
C
C        CALCULATION CONTROL CARD
```

```
      C
      C
      C         5                  NUMBER OF FILTERS
      C        10                  NUMBER OF DATA FIELDS FOR FILTER ONE
      C        15                  NUMBER OF DATA FIELDS FOR FILTER TWO
      C         20-65 BY 5                FILTER CALCULATIONS
      C        70                  NUMBER OF FIELDS FOR CALIBRATION DATA
      C        74,75               GENERAL WEIGHTING FUNCTION
      C
      C          DISTANCE FACTOR  CARD
      C
      C         1-9           DISTANCE FACTOR FOR ULTRAVIOLET LIGHT
      C        10-18          DISTANCE FACTOR FOR VISIBLE LIGHT
      C
      C
      C      GENERAL DATA CARD
      C
      C         1-4                WAVE LENGTH
      C         9-17               DATA---- WHERE DATA IS CALIBRATION
      C                                      FACTOR, B-LAMBDA , X-BAR LAMBDA , Y-BAR
      C                                      LAMBDA , Z-BAR LAMBDA , P445 LAMBDA ,
      C                                      P535 LAMBDA , P575 LAMBD , COMPUTED
      C                                      FILTER DATA, DATA READINGS
      C
      C      FILTER DATA IN RAW FORM
      C
      C         1-4                WAVE LENGTH
      C         9-17               DIVIDEND
      C        25-33               DIVISOR
      C
      C      BIO-DECK
      C
      C         1-4                WAVE LENGTH
      C         5-13               S-LAMBDA
      C        14-22               U-LAMBDA
      C        23-31               V-LAMBDA
      C        32-40               VP-LAMBDA
      C        41-49               T-LAMBDA
      C        50-58               TA-LAMBDA
      C        59-67               CA-LAMBDA
      C        68-76               A-LAMBDA
      C
      C      EVENT NAME  CARD
      C
      C         1-18               EVENT NAME
      C
      C      SCURCE SOLID ANGLE CARD
      C
      C         1-9                OMEGA
      C
      C
      C      END CARD
      C
      C         1-3                END
      C
      C
      C
```

```
C         PRINTER LAYOUT
C
C           2-6                 WAVE LENGTH
C           9-17                CALIBRATION FACTOR
C          20-28                INSTRUMENT READINGS
C          31-39                ADJUSTED INSTRUMENT READINGS
C          42-50                SPECTRAL IRRADIANCE OF SOURCE
C          53-61                SPECTRAL RADIANCE OF SOURCE
C          64-72                3-MM SPECTRAL-RETINAL IRRADIANCE
C          75-83                7-MM SPECTRAL-RETINAL IRRADIANCE
C          86-94                GENERAL WEIGHTING FUNCTION RESULTS
C          97-105               SPECTRAL FILTER TRANSMISSIONS FOR FILTER ONE
C         108-116               SPECTRAL FILTER TRANSMISSIONS FOR FILTER TWO
C         119-127               SPECTRAL FILTER TRANSMISSIONS FOR BOTH FILTERS
C
C         SINGLE WAVE CALCULATIONS
C
C           3-96                RESULT DESCRIPTION
C         100-108               RESULT
C
C           FILE RS$SWP-PLOT LAY OUT
C
C           1-9                 ELAMBDA
C
C
C
C
C         BIODECK TABLES
C
          REAL      SLAMBD(340,2)  @ ACGIH UV HAZARD ENVELOPE FUNCTION
          REAL      ULAMBD(340,2)  @ 1936 CIE UV SKIN ERYTHEMA ACTION SPECTRUM
          REAL      ALAMBD(340,2)  @ ANSI Z136 LASER WEIGHTING-UV HAZARD FUNCTION
          REAL      TLAMBD(340,2)  @ OCULAR MEDIA TRANSMISSION
          REAL      TALAMB(340,2)  @ ABSORPTION IN THE RETINA
          REAL      CALAMB(340,2)  @ RECIPROCAL OF ANSI-NEAR-INFRARED RETINAL
C                                    BURN CORRECTION FACTOR
          REAL      VLAMBD(340,2)  @ CIE-1970 PHOTOPIC VISIBILITY FUNCTION
          REAL      VPLAMB(340,2)  @ CIE-1970 SCOTOPIC VISIBILITY FUNCTION
          REAL      BLAMBD(340,2)  @ ACGIH BLUE-LIGHT HAZARD FUNCTION
          REAL      XBLAMB(340,2)  @ CIE-1931 BLUE CHROMATICITY COORDINATE
          REAL      YBLAMB(340,2)  @ CITE-1931 GREEN CHROMATICITY COORDINATE
          REAL      ZBLAMB(340,2)  @ CIE-1931  RED  CHROMATICITY COORDINATE
          REAL      P445LB(340,2)  @ DARTNALL NOMORGRAM ABSORPTION COEFFICIENT BLUE
          REAL      P535LB(340,2)  @ DARTNALL NOMOGRAM ABSORPTION COEFFICIENT GREEN
          REAL      P575LB(340,2)  @ DARTNALL NOMOGRAM ABSORPTION COEFFICIENT FO- -ED
C
C         END BIODECK TABLES
C
          REAL      DFV            @ DISTANT FACTOR TO ADJUST VISIBLE RADIATION
C                                    CALIBRATION FACTOR
          REAL      DFU            @ DISTANT FACTOR TO ADJUST UV RADIATION
C                                    CALIBRATION FACTOR
          REAL      DP(2)          @ PUPIL SIZE USED IN RETINA CALCULATIONS
          REAL      OMEGA          @ SOURCE SOLID ANGLE FOR SPECTRAL READINGS
          REAL      EINSTR(340,2)  @ SPECTRAL READINGS OF SOURCE UNDER STUDY
          REAL      FOFX(340,2)    @ FUNCTION TO MODIFY INSTRUMENT READINGS
          REAL      CF(340,2)      @ CALIBRATION FACTOR
```

```
        REAL     EIFOFX(340,2)    @ ADJUSTED INSTRUMENT READINGS
        REAL     ELAMBD(340,2)    @ SPECTRAL IRRADIANCE OF SOURCE UNDER STUDY
        REAL     LLAMBD(340,2)    @ SPECTRAL RADIANCE OF SOURCE UNDER STUDY
        REAL     ERETLB(340,3)    @ SPECTRAL-RETINAL IRRADIANCE FOR 3 AND 7-MM PUPIL
        REAL     EDELLB           @ TOTAL SPECTRAL IRRADIANCE OF SOURCE
        REAL     LDELLB           @ TOTAL RADIANCE OF SOURCE
        REAL     ACGIH            @ EFFECTIVE UV RADIATION ACCORDING TO THE
C                                   ACGIH STANDARD ACTION SPECTRUM
        REAL     CIE              @ EFFECTIVE UV RADIATION ACCORDING TO THE
C                                   1936 CIE UV ERYTHEMA ACTION SPECTRUM
        REAL     ANSI             @ EFFECTIVE UV RADIATION ACCORDING TO THE
C                                   ANSI-Z136 LASER WEIGHTING UV HAZARD FUCTION
        REAL     BLUHAZ           @ BLUE LIGHT HAZARD FUCTION WEIGHTED AGAINST
C                                   SPECTRAL IRRADIANCE
        REAL     XBAR             @ 1931 BLUE CHROMATICITY COORDINATES WEIGHTED
C                                   AGAINST SPECTRAL IRRADIANCE
        REAL     YBAR             @ 1931 GREEN CHROMATICITY COORDINATES WEIGHTED
C                                   AGAINST SPECTRAL IRRADIANCE
        REAL     ZBAR             @ 1931 RED   CHROMATICITY COORDINATES WEIGHTED
C                                   AGAINST SPECTRAL IRRADIANCE
        REAL     P445             @ DARTNELL NOMOGRAM ABSORPTION COEFFICIENT FOR
C                                   BLUE  WEIGHTED AGAINST SPECTRAL IRRADIANCE
        REAL     P535             @ DARTNELL NOMOGRAM ABSORPTION COEFFICIENT FO-
C                                   GREEN WEIGHTED AGAINST SPECTRAL IRRADIANCE
        REAL     P575             @ DARTNELL NOMOGRAM ABSORPTION COEFFICIENT FOR
C                                    RED  WEIGHTED AGAINST SPECTRAL IRRADIANCE
        REAL     VE               @ RADIANT EFFACACY OF RADIATION FROM LAMBDA-MIN
C                                   TO LAMBDA-MAX
        REAL     VIE              @ FRACTION CIE SCOTOPIC RADIATION FROM LAMBDA-MIN
C                                   TO LAMBDA-MAX
        REAL     TRANS            @ EFFECTIVE TRANSMISSION OF OCULAR MEDIA FROM
C                                   LAMBDA-MIN TO LAMBDA-MAX
        REAL     TRANTX           @ EFFECTIVE TRANSMISSION OF OCULAR MEDIA
C                                   MULTIPLIED BY SPECTRAL ABSORPTION OF OCULA-
C                                   MEDIA
        REAL     EECA             @ ANSI LASER MPE WEIGHTING FACTOR FOR VIS+BLE
C                                   AND INFRARED-A
        REAL     PCTUV            @ PERCENT OF TOTAL IRRADIANCE WHICH IS UV
C                                   RADIATION
        REAL     PCTVI            @ PERCENT OF TOTAL IRRADIANCE WHICH IS VISIBLE
C                                   RADIATION
        REAL     PCTNIR           @ PERCENT OF TOTAL IRRADIANCE WHICH IS  NEAR
C                                   INFRARED RADIATION
        REAL     ILLUM            @ ILLUMINANCE IN LAMENS PER SQUARE CENTIMETER
        REAL     LUMIN            @ LUMINANCE IN CANDELAS PER SQUARE CENTIMETE-
        REAL     DATA             @ INPUT BUFFER FOR TABLE DATA
        REAL     DATA1            @ INPUT BUFFER FOR TABLE DATA
        REAL     WAVE             @ WAVELENGTH ASSOCIATED WITH DATA AND DATA1
        REAL     FT1(340,2)       @ FILTER ONE DATA TABLE
        REAL     FT2(340,2)       @ FILTER TWO DATA TABLE
        REAL     EFT(340,4)       @SPECTRAL FILTER TRANSMISSION FOR FILTER ONE AND
C                                  FILTER TWO AND FOR BOTH FILTERS
        REAL     FILTER(9)        @ EFFECTIVE UV IRRADIANCE ACCORDING TO THE
C                                   THREE ACTION SPECTRA THROUGH EITHER FILTER
C                                   OR BOTH FILTERS
        REAL     GLAMBD(340,2)    @ GENERAL WEIGHTING TABLE
        REAL     DELTA(340)       @ TABLE OF WAVE LENGTH INCREMENTS FOR EINSTR DATA
```

```
      REAL     PREV            @ DURING INPUT OF READINGS,CONTAINS THE
C                                VALUE OF THE LAST CARD READ
      INTEGER  LAMBDA(3,2)
      INTEGER  FLTCNT(3,2)
      INTEGER  CAL
      INTEGER  GENFUN          @ INDICATES WHETHER GENERAL FUNCTION DATA
C                                IS TO BE READ
      INTEGER  GENWEI          @ THE GENERAL WEIGHTING FUNCTION TO CALCUATE
      INTEGER  FILCAL(9)       @ INDICATES WHICH FILTER CALCULATIONS ARE TO
C                                BE PERFORMED
      INTEGER  CALHDR(14)  @ DESCRIPTION OF CALIBRATION DATA
      INTEGER  DESCRP(28)      @ DESCRIPTION OF SOURCE UNDER STUDY
      INTEGER  NUMFIL          @ NUMBER OF FILTER
      INTEGER  NOCOF1   @ NUMBER OF DATA FIELDS FOR FILTER ONE
      INTEGER  NOCOF2   @ NUMBER OF DATA FIELDS FOR FILTER TWO
      INTEGER  GENERL
      INTEGER  CALDAT          @ INDICATES WHETHER CALIBRATION DATA WILL BE INPUT
C                                AS RAW DATA OR CALCULATED DATA
      INTEGER  EVENT(3)        @ EVENT NUMBER OF RUN DATA READINGS
      INTEGER EVENT2(12)
      INTEGER  PAGE            @ PAGE COUNT FOR LISTING
      INTEGER  DATE(2)         @ DATE OF THE RUN
      INTEGER  ENDMK           @ INDICATE WHETHER DATA SET WAS ENDED CORRECTLY
      INTEGER  PRTLAM(16,3)    @ USED IN LIST HEADING FOR GENERAL WEIGHTING
C                                FUNCTION COLUMN
      INTEGER  LSTWAV          @ CONTAINS LAST WAVE LENGTH DURING CALCULATIONS
      INTEGER  PEAK            @ INPUT THAT INDICATES WHETHER VALUE IS A
C                                PEAK VALUE
      INTEGER  BANPAS(3)       @ BAND PASS WITH USED WHEN COMPUTING WITH
C                              @ PEAK VALUE
      INTEGER FWAVE
      DATA(BANPAS(I),I=1,3)/3,5,10/
      DATA ((PRTLAM(I,J),J=1,3),I=1,16)/
     1' (NOT ','USED) ','            ',
     2'  (S-L','AMBDA)','            ',
     3'  (U-L','AMBDA)','            ',
     4'  (A-L','AMBDA)','            ',
     5' (T-L','AMBDA)','             ',
     6' (T-A-','LAMBDA',')           ',
     7' (C-A-','LAMBDA',')           ',
     8'  (V-L','AMBDA)','            ',
     9' (V+-L','AMBDA)','            ',
     A' (B-L','AMBDA)','             ',
     B'(X-BAR',' LAMBD','A)          ',
     C'(Y-BAR',' LAMBD','A)          ',
     D'(Z-BAR',' LAMBD','A)          ',
     E'    (P-','445)  ','           ',
     F'    (P-','535)  ','           ',
     G'    (P-','575)  ','           '/
      DATA (( LAMBDA(I,J),J=1,2),I=1,3)/
     1     'S-LA' , 'MBDA',
     2     'U-LA' , 'MBDA',
     3     'A-LA' , 'MBDA'/
      DATA ((FLTCNT(I,J),J=1,2),I=1,3)/
     1      ' FILTE' , 'R ONE ',
     2      ' FILTE' , 'R TWO ',
     3      'BOTH F' , 'ILTERS'/
```

```
      DATA EVENT2 / 'FIGURE','   . A','BSOLUT','E SPEC','TRAL I',
     1'RRADIA','NCE AT','     C','M FOR',' ',' ',' ' /
    2 CONTINUE
      DP(1) = .09              @ .3CM SQUARED
      DP(2) = .49              @ .7CM SQUARED
      WAVE = 200
C
C     INITIALIZE GENERAL FUNCTION TO UNITY.  IF ANOTHER FUNCTION IS DESIRED
C     IT WILL BE INPUT BY CARDS AND AFFECT ONLY THE SPECIFIED RANGES
C
      DO 5 I = 1,240
      FOFX(I,1) = WAVE
      FOFX(I,2) = 1
      WAVE = WAVE + 5
    5 CONTINUE
C
C     READ SOURCE DESCRIPTION
C
      READ 10,(DESCRP(I),I=1,14)
      READ 10,(DESCRP(I),I=15,28)
   10 FORMAT(13A6,A2)
C
C     READ CALCULATION CONTROL CARD
C
      READ 30,NUMFIL,NOCOF1,NOCOF2,FILCAL,CALDAT,GENWEI,GENFUN
   30 FORMAT(15I5)
C
C     READ THE CALIBRATION DATA
C
      READ 40,DFU,DFV
   40 FORMAT(2F9.2)
      ITCAL=CALDAT+1
      GO TO (45,130,126),ITCAL
C
C  45-- CALIBRATION IS RAW, CF IS TO BE CALCULATED.
C  130- CALIBRATION IS PRE-CALCULATED.
C  126- CALIBRATION IS ALL ONE'S, PROGRAM GENERATES TABLE.
C
   45 READ 35,CALHDR
   35 FORMAT(13A6,A2)
C
C     THE CALIBRATION INPUT IS THE RAW DATA AND CF MUST BE COMPUTED
      DO 60 I = 1,341
         READ(5,50,ERR=70) CF(I,1),CF(I,2)
   50    FORMAT(F4.0,T9,E9.2)
   60 CONTINUE
   70 READ(0,80) ENDMK
   80 FORMAT(A3)
      IF(ENDMK .EQ. 'END') GOTO 100
      PRINT 90
   90 FORMAT('0','CALIBRATION DATA NOT ENDED CORRECTLY')
      STOP
  100 DO 110 J = 1,341
         READ(5,50,ERR=120) WAVE,DATA
      IF (IFIX(WAVE+0.01) .EQ. IFIX(CF(J,1)+0.01)) GOTO 96
         PRINT 95,WAVE
   95    FORMAT('0 WAVE LENGTH ',F5.0,' OF SPECTRAL IRRADIANCE DOES',
```

```
     1              'NOT MATCH WAVE LENGTH OF READING FOR CALIBRATION',
     2              'FACTOR.')
           STOP
  96       IF(DATA .NE. 0) GOTO 98
           PRINT 99,WAVE
  99       FORMAT('0 DIVISION BY ZERO IN CALIBRATION FACTOR SECTION AT',
     1              'WAVE LENGTH  ',F5.0)
           STOP
  98       IF(WAVE .GT. 300) GOTO 97
           CF(J,2) = CF(J,2) / DATA * DFU
           GOTO 110
  97       CF(J,2) = CF(J,2) / DATA * DFV
  110 CONTINUE
  120 IF(I .EQ. J) GOTO 125
      PRINT 121
  121 FORMAT('0 CALIBRATION FACTOR ERROR - NUMBER RAW DATA NOT MATCHED')
      STOP
  125 READ(0,80) ENDMK
      IF(ENDMK .EQ. 'END') GOTO 170
      PRINT 90
      STOP
C
C  GENERATE CF TABLE FROM 200-1400(WAVELENGTHS)--ALL VALUES = 1.
  126 CONTINUE
      VAL=195
      DO 127 I=1,341
       CF(I,1)=VAL+5
       VAL=CF(I,1)
       CF(I,2)=1.0
 127  CONTINUE
      GO TO 170
C
C     READ COMPUTED CALIBRATION DATA
C
  130 READ 35,CALHDR
      DO 150 I = 1,341
      READ(5,140,ERR=160) (CF(I,J),J=1,2 )
  140 FORMAT(F4.0,T9,E9.2)
      IF(CF(I,1) .GT. 300) GOTO 135
      CF(I,2) = CF(I,2) * DFU
      GOTO 150
  135 CF(I,2) = CF(I,2) * DFV
  150 CONTINUE
  160 READ(0,80 ) ENDMK
      IF(ENDMK .EQ. 'END') GOTO 170
      PRINT 90
      STOP
  170 CONTINUE
C
C     READ BIODECK
C
      DO 190 I = 1,341
      READ(5,180,ERR=200) WAVE,SLAMBD(I,2),ULAMBD(I,2),VLAMBD(I,2),
     1VPLAMB(I,2),TLAMBD(I,2),TALAMB(I,2),CALAMB(I,2),ALAMBD(I,2)
  180 FORMAT(F4.0,8E9.2)
      SLAMBD(I,1) = WAVE
      ULAMBD(I,1) = WAVE
```

```
      VLAMBD(I,1) = WAVE
      VPLAMB(I,1) = WAVE
      TLAMBD(I,1) = WAVE
      TALAMB(I,1) = WAVE
      CALAMB(I,1) = WAVE
      ALAMBD(I,1) = WAVE
  190 CONTINUE
  200 READ(0,210) ENDMK
  210 FORMAT(A3)
      IF(ENDMK .EQ. 'END') GOTO 230
      PRINT 220,I
  220 FORMAT('0','BIODECK HAS NO END CARD AT IMAGE ',I3)
      STOP
  230 CONTINUE
C
C
      CALL BDREAD(BLAMBD)
      CALL BDREAD(XBLAMB)
      CALL BDREAD(YBLAMB)
      CALL BDREAD(ZBLAMB)
      CALL BDREAD(P445LB)
      CALL BDREAD(P535LB)
      CALL BDREAD(P575LB)
C
C     READ FILTER TRANSMISSION FUNCTION(S),IF ANY
C     FILTER TWO DATA IS READ FIRST.
C
      I = NUMFIL + 1
      GOTO(450,290,390),I
C
C     DETERMINE NUMBER OF DATA FIELDS FOR FILTER ONE
C
  290 GOTO(300,360),NOCOF1
C
C     ONE DATA FIELD FOR FILTER ONE
C
  300 DO 320 I = 1,341
      READ(5,310,ERR=330)(FT1(I,K),K=1,2)
  310 FORMAT(F4.0,T3,E9.2)
  320 CONTINUE
  330 READ(0,340) ENDMK
  340 FORMAT(A3)
      IF(ENDMK .EQ. 'END') GOTO 450
  345 PRINT 350
  350 FORMAT('0','FILTER DATA WAS NOT ENDED CORRECTLY')
      STOP
C
C     TWO DATA FIELDS FOR FILTER ONE
C
  360 DO 380 I = 1,341
      READ (5,370,ERR=330) FT1(I,1),DATA,DATA1
  370 FORMAT(F4.0,T9,2E9.2)
      FT1(I,2) = DATA / DATA1
  380 CONTINUE
      GOTO 345
C
C     DETERMINE NUMBER OF DATA FIELDS FOR FILTER TWO
```

```
      C
  390 GOTO(400,430),NOCOF2
      C
      C     ONE DATA FIELD FOR FILTER TWO
      C
  400 DO 410 I = 1,341
      READ(5,310,ERR=420)(FT2(I,K),K=1,2 )
  410 CONTINUE
      GOTO 345
  420 READ(0,340) ENDMK
      IF(ENDMK .EQ. 'END') GOTO 290
      GOTO 345
      C
      C     TWO DATA FIELDS FOR FILTER TWO
      C
  430 DO 440 I = 1,341
      READ(5,370,ERR=420) FT2(I,1),DATA, DATA1
      FT2(I,2) = DATA / DATA1
  440 CONTINUE
      GOTO 345
      C
      C     READ GENERAL FUNCTION, INPUT CONTAINS THE FIRST AND LAST WAVE LENGTH
      C     AFFECTED BY FUNCTION
      C
  450 IF(GENFUN .EQ. 0) GOTO 520
      READ(5,460,ERR=480) FWAVE,LWAVE,DATA
  460 FORMAT(I4,T10,I4,T20,E9.2)
      C
      C     DETERMINE THE TABLE ELEMENT NUMBERS FOR THE WAVE LENGTH INTERVALS
      C
      J = (FWAVE - 200) / 5 + 1
      K = (LWAVE - 200) / 5 + 1
      C
      C     INSERT THE FUNCTION INTO THE CORRECT ELEMENTS OF THE GENERAL FUNCTION
      C     TABLE
      C
      DO 465 L = J,K
      FOFX(L,2) = DATA
  465 CONTINUE
      GOTO 520
  480 PRINT 510
  510 FORMAT('0','INCORRECT GENERAL FUNCTION CARD' )
      STOP
  520 CONTINUE
      CALL IDENT
      C
      C     READ SPECTRAL DATA OF SOURCE UNDER STUDY
      C
      C          READ THE EVENT NUMBER OF THE DATA
      C
  530 READ(5,540,END=9999) EVENT
  540 FORMAT(3A6)
      C
      IF (EVENT(1) .EQ. 'NEXT')  GO TO 2
      C          READ SOURCE SOLID ANGLE
      C
      READ 550,OMEGA
```

```
  550 FORMAT(E9.2)
C
C           READ THE DATA READINGS
C
      PREV = 0
      DO 570 I = 1,341
  555 READ(5,560,ERR=580) (EINSTR(I,K),K=1,2),PEAK
  560 FORMAT(F4.0,T9,E9.2,T20,A4)
C
C     IF PRESENT WAVE LENGTH IS LESS THAN OR EQUAL TO THE PREVIOUS WAVE
C     LENGTH DISREGARD IT AND READ THE NEXT CARD
C
      IF(PREV .LT. EINSTR(I,1)) GOTO 561
      PRINT 562,(EINSTR(I,K),K=1,2)
  562 FORMAT(' SOURCE DATUM DISREGARDED - ',F4.0,E9.2)
      GOTO 555
  561 PREV = EINSTR(I,1)
C
C     IF THE VALUE IS A PEAK VALUE THEN NEGATE THE WAVE LENGTH TO INDICATE
C     THAT THE VALUE ASSOCIATED WITH THIS WAVE LENGTH IS A PEAK VALUE
C
      IF(PEAK .EQ. 'PEAK') EINSTR(I,1) = EINSTR(I,1) * (-1)
  570 CONTINUE
      GOTO 600
  580 READ(0,590) ENDMK
  590 FORMAT(A3)
      IF(ENDMK .EQ. 'END') GOTO 620
  600 PRINT 610
  610 FORMAT('0','SPECTRAL READINGS WERE NOT ENDED CORRECTLY')
      STOP
  620 CONTINUE
      MAXELM=I-1
C
C     COMPUTE THE DELTA ASSOCIATED WITH EACH WAVE LENGTH.  THIS IS DONE
C     IN THE FOLLOWING WAY:
C
C     1)  DETERMINE THE DELTA FOR THE FIRST WAVE LENGTH.  IF THE WAVE
C         LENGTH IS LESS THAN ZERO, IT IT A PEAK AND DELTA IS SET TO CORRECT
C         BANPAS VALUE. IF IT IS NOT A PEAK THEN DELTA EQUALS ONE HALF OF
C         THE DIFFERENCE BETWEEN THE FIRST TWO CONSECUTIVE NON-PEAK WAVE
C         LENGTHS
C
C     2)  COMPUTE THE REST OF THE DELTAS. PEAK VALUES GET THE CORRECT
C         BANPAS VALUE.  FOR NON-PEAK VALUES, MUST KEEP TRACK OF LAST
C         NON-PEAK WAVE LENGTH AND THE WAVE LENGTH INTERVAL, ALSO MUST
C         KNOW IF THE LAST VALUE WAS A PEAK THAT FELL ON A WAVE INTERVAL
C         WHICH WILL BE TREATED HAS A NON-PEAK FOR THE NEXT NON-PEAK DELTA
C         VALUE.  SO DELTA FOR NON PEAK VALUE IS THE DIFFERENCE BETWEEN
C         THE PRESENT WAVE LENGTH AND THE PREVIOUS NON-PEAK WAVE LENGTH.
C
      IF(EINSTR(1,1).LT.0) GOTO 623
      DIV = 2
      WAVE1 = EINSTR(1,1)
      LMN = 3
      WAVE2 = EINSTR(2,1)
      IJK = 2
  619 DO 621 I =      LMN,MAXELM
```

```
      IF(WAVE1 .GT. 0 .AND. WAVE2 .GT. 0 ) GOTO 622
      WAVE1 = WAVE2
      WAVE2 = EINSTR(I,1)
  621 CONTINUE
C
C     COME HERE WHEN TWO CONSECUTIVE NON PEAK VALUES ARE FOUND AND COMPUTE
C     DELTA FOR FIRST NON-PEAK VALUE
C
  622 DELTA(1) =(WAVE2 - WAVE1) / DIV
      LSTWAV = EINSTR(IJK-1,1)        @ LAST NON-PEAK WAVE LENGTH
      INTVL = DELTA(1) * DIV          @ INTERVAL BETWEEN 2 CONSECUTIVE NON-PEAKS
      GOTO 626
C
C     FIRST VALUE IS A PEAK SO DO LOOP UNTIL A NON-PEAK VALUE IS FOUND
C
  623 DO 624 J = 1,MAXELM
      DELTA(J) = BANPAS(3)
      IF(EINSTR(J,1) .GT. -700) DELTA(J) = BANPAS(2)
      IF(EINSTR(J,1) .GT. -400) DELTA(J) = BANPAS(1)
      IF(EINSTR(J+1,1) .GT. 0) GOTO 625
  624 CONTINUE
  625 DIV = 1
      IJK = J+2
      WAVE 1 = EINSTR(J+1,1)
      WAVE2 = EINSTR(J+2,1)
      LMN = J + 3
      GOTO 619
C
C     PROGRAM GOT HERE AFTER IT HAS DETERMINE DELTA FOR THE FIRST NON-PEAK
C     VALUE AND ANY PEAK VALUE THAT WAS BEFORE IT
C
  626 DO 629 I = IJK,MAXELM
      IF(EINSTR(I,1)) 627,631,628
C
C     PRESENT VALUE IS A PEAK, IF PEAK IS ON A NON-PEAK INTERVAL THEN
C     PEAK WAVE BECOMES LAST WAVE LENGTH
C
  627 IF ( EINSTR(I,1) - LSTWAV .EQ. INTVL ) LSTWAV = EINSTR(I,1)
      DELTA(I) = BANPAS(3)
      IF(EINSTR(I,1) .GT. -700) DELTA(I) = BANPAS(2)
      IF(EINSTR(I,1) .GT. -400) DELTA(I) = BANPAS(1)
      GOTO 629
C
C     PRESENT VALUE IS NON-PEAK
C
  628 DELTA(I) = EINSTR(I,1) - LSTWAV
      LSTWAV = EINSTR(I,1)
      INTVL = DELTA(I)
  629 CONTINUE
  631 CONTINUE
C
C     CALCULATION SECTION FOLLOWS
C
C
C     IT IS NOT NECESSARY THAT THE WAVE LENGTH INTERVAL OF THE SPECTRAL
C     READINGS OR ANY OF INTERMEDIATE VALUES CORRESPOND TO THE WAVE
C     LENGTH INTERVAL OF THE BIOLOGICAL DATA AND THE CALIBRATION DATA.
```

```
      C     IT IS THEREFORE NECESSARY IN EACH CALCULATION SECTION TO MATCH UP
      C     BIO AND CAL DATA WITH THE CORRESPONDING SPECTRAL AND INTERMEDIATE
      C     RESULTS DATA.  IF SPECTRAL READING FALL BETWEEN BIO DATA AND CAL
      C     DATA THEN THE BIO AND CAL DATA WILL HAVE TO BE INTERPOLLATED FOR
      C     THE WAVE LENGTH OF SPECTRAL DATA.DO TO THE FACT THAT THE PROGRAM
      C     NEGATES THE WAVE LENGTH OF PEAK READINGS IT IS NECESSARY WHEN
      C     COMPARING WAVE LENGTHS TO USE THE ABSOLUTE VALUE OF THE WAVE
      C     LENGTH FOR SPECTRAL READING DATA
      C
      C     CALCULATE ADJUSTED INSTRUMENT READINGS
      C
            K = 1
            DO 640 I = 1,MAXELM
        633 IF(FOFX(K,1) .EQ. ABS(EINSTR(I,1))) GOTO 630
            IF(ABS(EINSTR(I,1)) .LT. FOFX(K,1)) GOTO 638
            K = K + 1
            GOTO 633
        638 EIFOFX(I,1) = ABS(EINSTR(I,1))
            EIFOFX(I,2) = EINSTR(I,2) * FOFX(K-1,2)
            GOTO 640
        630 EIFOFX(I,1) = ABS(EINSTR(I,1))
            EIFOFX(I,2) = EINSTR(I,2) * FOFX(K,2)
            K = K + 1
        640 CONTINUE
      C
      C     CALCULATE SPECTRAL IRRADIANCE OF SOURCE UNDER STUDY
      C
            K = 1
            DO 690 I = 1,MAXELM
        645 IF(EIFOFX(I,1) .NE. CF(K,1)) GOTO 680
            IF(CF(K,2) .NE. 0) GOTO 670
        650 PRINT 660,EIFOFX(I,1)
        660 FORMAT('0 ATTEMPT TO DIVIDE A CALIBRATION FACTOR OF ZERO INTO ADJU
           1STEP INSTRUMENT READING AT WAVE LENGTH    ',F5.0)
            STOP
        670 ELAMBD(I,1) = EIFOFX(I,1)
            ELAMBD(I,2) = EIFOFX(I,2) / CF(K,2)
            K = K + 1
            GOTO 690
        680 IF(EIFOFX(I,1) .LT. CF(K,1)) GOTO 685
            K = K + 1
            GOTO 645
        685 CALL INTERP(EIFOFX,CF,I,K,CALFAC)
            IF(CALFAC .EQ. 0) GOTO 650
            ELAMBD(I,1) = EIFOFX(I,1)
            ELAMBD(I,2) = EIFOFX(I,2) / CALFAC
        690 CONTINUE
      C
      C     CALCULATE SPECTRAL RADIANCE OF SOURCE UNDER STUDY
      C
            DO 700 I = 1,MAXELM
            LLAMBD(I,1) = ELAMBD(I,1)
            LLAMBD(I,2) = ELAMBD(I,2) / OMEGA
        700 CONTINUE
      C
      C     CALCULATE SPECTRAL-RETINAL IRRADIANCE FOR 3-MM AND 7-MM PUPILS
      C
```

```
      K = 1
      DO 750 I = 1,MAXELM
  705 IF(LLAMBD(I,1) .NE. TLAMBD(K,1)) GOTO 720
      ERETLB(I,1) = LLAMBD(I,1)
      J = 2
      DO 710 L = 1,2
      ERETLB(I,J) = .27 * LLAMBD(I,2) * TLAMBD(K,2) * DP(L)
      J = J + 1
  710 CONTINUE
      K = K + 1
      GOTO 750
  720 IF(LLAMBD(I,1) .LT. TLAMBD(K,1)) GOTO 730
      K = K + 1
      GOTO 705
  730 CALL INTERP(LLAMBD,TLAMBD,I,K,TLRES)
      ERETLB(I,1) = LLAMBD(I,1)
      J = 2
      DO 740 L = 1,2
      ERETLB(I,J) = .27 * LLAMBD(I,2) * TLRES * DP(L)
      J = J + 1
  740 CONTINUE
  750 CONTINUE
C
C     CALCULATE SPECTRAL FILTER TRANSMISSION FOR ONE FILTER
C
      IF(NUMFIL) 830,830,755
  755 K = 1
      DO 780 I = 1,MAXELM
  760 IF(ELAMBD(I,1) .NE. FT1(K,1)) GOTO 765
      FTRES = FT1(K,2)
      GOTO 775
  765 IF(ELAMBD(I,1) .LT. FT1(K,1)) GOTO 770
      K = K + 1
      GOTO 760
  770 CALL INTERP(ELAMBD,FT1,I,K,FTRES )
  775 EFT(I,1) = ELAMBD(I,1)
      EFT(I,2) = ELAMBD(I,2) * FTRES
      K = K +1
  780 CONTINUE
C
C     CALCULATE SPECTRAL FILTER TRANSMISSION FOR TWO FILTER
C
      GOTO(830,785),NUMFIL
  785 K = 1
      J = 1
      DO 825 I = 1,MAXELM
  790 IF(ELAMBD(I,1) .EQ. FT1(J,1)) GOTO 800
      IF(ELAMBD(I,1) .LT. FT1(J,1)) GOTO 795
      J = J +1
      GOTO 790
  795 CALL INTERP(ELAMBD,FT1,I,J,FT1RES)
      GOTO 805
  800 FT1RES = FT1(J,2)
  805 IF(ELAMBD(I,1) .EQ. FT2(K,1)) GOTO 815
      IF(ELAMBD(I,1) .LT. FT2(K,1)) GOTO 810
      K = K +1
      GOTO 805
```

```
  810 CALL INTERP(ELAMBD,FT2,I,K,FT2RES)
      GOTO 820
  815 FT2RES = FT2(K,2)
  820 EFT(I,3) = ELAMBD(I,2) * FT2RES
      EFT(I,4)= ELAMBD(I,2) * FT2RES * FT1RES
      K = K + 1
      J = J + 1
  825 CONTINUE
  830 CONTINUE
C
C     DETERMINE IF A GENERAL WEIGHTING TABLE IS TO BE CALCULATED
C
      GENERL = GENWEI + 1
      GOTO(860,870,880,890,900,910,920,930,940,950,960,970,980,990,1000,
     11010),GENERL
  860 GOTO 1020                             @ DO NOT CALCULATE TABLE
  870 CALL GLAMCO(GLAMBD,ELAMBD,SLAMBD,$1020)
  880 CALL GLAMCO(GLAMBD,ELAMBD,ULAMBD,$1020)
  890 CALL GLAMCO(GLAMBD,ELAMBD,ALAMBD,$1020)
  900 CALL GLAMCO(GLAMBD,ELAMBD,TLAMBD,$1020)
  910 CALL GLAMCO(GLAMBD,ELAMBD,TALAMB,$1020)
  920 CALL GLAMCO(GLAMBD,ELAMBD,CALAMB,$1020)
  930 CALL GLAMCO(GLAMBD,ELAMBD,VLAMBD,$1020)
  940 CALL GLAMCO(GLAMBD,ELAMBD,VPLAMB,$1020)
  950 CALL GLAMCO(GLAMBD,ELAMBD,BLAMBD,$1020)
  960 CALL GLAMCO(GLAMBD,ELAMBD,XBLAMB,$1020)
  970 CALL GLAMCO(GLAMBD,ELAMBD,YBLAMB,$1020)
  980 CALL GLAMCO(GLAMBD,ELAMBD,ZBLAMB,$1020)
  990 CALL GLAMCO(GLAMBD,ELAMBD,P445LB,$1020)
 1000 CALL GLAMCO(GLAMBD,ELAMBD,P535LB,$1020)
 1010 CALL GLAMCO(GLAMBD,ELAMBD,P575LB,$1020)
 1020 CONTINUE
      DO 1040 I = 1,MAXELM
      IF (EINSTR(I,1)) 1030,1040,1040
 1030 ELAMBD(I,1) = EINSTR(I,1)
      LLAMBD(I,1) = EINSTR(I,1)
 1040 CONTINUE
C
C     CALCULATE TOTAL SPECTRAL IRRADIANCE FOR WAVE LIMITS USED FOR
C     INSTRUMENT READINGS
C
      ITEST = 0
      GOTO 1045
 1041 DO 1141 II=1,MAXELM
 1141 ELAMBD(II,2)=EFT(II,2)
      ITEST = 1
      GOTO 1045
 1042 DO 1142 II=1,MAXELM
 1142 ELAMBD(II,2)=EFT(II,3)
      ITEST = 2
      GOTO 1045
 1043 DO 1143 II=1,MAXELM
 1143 ELAMBD(II,2)=EFT(II,4)
      ITEST = 3
 1045 L = 1
      EDELLB = SUM1(ELAMBD,DELTA,L,MAXELM)
C
```

```
C       CALCULATE RADIANCE OF SOURCE FROM LAMBDA-MIN TO LAMBDA-MAX
C
        LDELLB = EDELLB/OMEGA
C
C       CALCULATE EFFECTIVE ULTRAVIOLET RADIATION ACCORDING TO THE ACGIH
C       STANDARD ACTION SPECTRUM
C
        ACGIH = SUM(ELAMBD,SLAMBD,DELTA)
C
C       CALCULATE EFFECTIVE ULTRAVIOLET RADIATION ACCORDING TO THE 1936 CIE
C       ULTRAVIOLET ERYTHEMA ACTION SPECTRUM
C
        CIE = SUM(ELAMBD,ULAMBD,DELTA)
C
C       CALCULATE EFFECTIVE ULTRAVIOLET RADIATION ACCORDING TO THE ANSI-Z136
C       LASER WEIGHTING UV HARZARD FUNCTION
C
        ANSI = SUM(ELAMBD,ALAMBD,DELTA)
C
C       CALCULATE BLUE LIGHT HAZARD FUNCTION WEIGHTED AGAINST SPECTRAL IRRADIANCE
C
        BLUHAZ = SUM(ELAMBD,BLAMBD,DELTA)
C
C       BLUE,GREEN,RED 1931 CHROMATICITY COORDINATES WEIGHTED AGAINST
C       SPECTRAL IRRADIANCE
C
        XBAR = SUM(ELAMBD,XBLAMB,DELTA)
        YBAR = SUM(ELAMBD,YBLAMB,DELTA)
        ZBAR = SUM(ELAMBD,ZBLAMB,DELTA)
C
C       DARTNALL NOMOGRAM ABSORPTION COEFFICIENT FOR BLUE,GREEN,RED
C       WEIGHTED AGINST SPECTRAL IRRADIANCE
C
        P445 = SUM(ELAMBD,P445LB,DELTA)
        P535 = SUM(ELAMBD,P535LB,DELTA)
        P575 = SUM(ELAMBD,P575LB,DELTA)
C
C       CALCULATE RADIANT EFFACACY OF RADIATION FROM LAMBDA-MIN TO LAMBDA-MAX
C
        VE = 680 * SUM(ELAMBD,VLAMBD,DELTA) / EDELLB
C
C       CALCULATE FRACTION CIE SCOTOPIC RADIATION FROM LAMBDA-MIN TO LAMBDA-MAX
C
        VIE = SUM(ELAMBD,VPLAMB,DELTA) / EDELLB
C
C       CALCULATE EFFECTIVE TRANSMISSION OF OCULAR MEDIA FROM MIN TO MAX LAMBDA
C
        TRANS = SUM(ELAMBD,TLAMBD,DELTA) / EDELLB
C
C       CALCULATE EFFECTIVE TRANSMISSION OF OCULAR MEDIA MULTIPLIED BY
C       SPECTRAL ABSORPTION OF OCULAR MEDIA
C
        TRANTX = SUM(ELAMBD,TALAMB,DELTA) / EDELLB
C
C       CALCULATE ANSI LASER MPE WEIGHTING FACTOR FOR VISIBLE AND INFRARED-A
C
        EECA = SUM(ELAMBD,CALAMB,DELTA) / EDELLB
```

```
      ILLUM = EDELLB * VE
      LUMIN = ILLUM / OMEGA
C
C     CALCULATE PERCENT OF TOTAL IRRADIANCE WHICH IS ULTRAVIOLET RADIATION
      L = 1
      I = 0
      PCTUV = 0
      IF(ELAMBD(1,1) .GT. 400) GOTO 1070
      DO 1050 I = 1,MAXELM
      IF(ELAMBD(I,1) .GT. 400) GOTO 1060
 1050 CONTINUE
 1060 IF(ELAMBD(I,1) .GT. 400) I = I - 1
      PCTUV = 100 * SUM1(ELAMBD,DELTA,L,I) / EDELLB
 1070 CONTINUE
C
C     CALCULATE PERCENT OF TOTAL IRRADIANCE WHICH IS VISIBLE RADIATION
C
      IF(I .EQ. MAXELM) GOTO 1110
      MINELM = I + 1
      IF(MINELM .LE. 1) MINELM = 1
      PCTVI = 0
      IF(ELAMBD(I,1) .GT. 700) GOTO 1100
      DO 1080 I = MINELM,MAXELM
      IF(ELAMBD(I,1) .GT. 700) GOTO 1090
 1080 CONTINUE
 1090 IF(ELAMBD(I,1) .GT. 700) I = I - 1
      PCTVI = 100 * SUM1(ELAMBD,DELTA,MINELM,I) / EDELLB
 1100 CONTINUE
C
C     CALCULATE PERCENT OF TOTAL IRRADIANCE WHICH IS NEAR INFRARED
C
      IF(I .EQ. MAXELM) GOTO 1110
      MINELM = I + 1
      IF(MINELM .LE. 1) MINELM = 1
      PCTNIR = 0
      PCTNIR= 100 * SUM1(ELAMBD,DELTA,MINELM,MAXELM) / EDELLB
 1110 IF (ITEST .NE. 0) GOTO 1515
C
C     CALCUATE TOTAL SPECTRAL IRRADIANCE WEIGHTED SPECTRALLY AGAINST
C     THE TRANSMISSION OF FILTER ONE,FILTER TWO AND BOTH FILTERS
C
      EEF1 = 0
      EEF2 = 0
      EEFIG2 = 0
      IF(NUMFIL) 1330,1330,1170
 1170 GOTO(1180,1200),NUMFIL
 1180 DO 1190 I = 1,MAXELM
      EEF1 = EEF1 + EFT(I,2) * DELTA(I)
 1190 CONTINUE
      GOTO 1220
 1200 DO 1210 I = 1,MAXELM
      EEF2 = EEF2 + EFT(I,3) * DELTA(I)
      EEFIG2 = EEFIG2 + EFT(I,4) * DELTA
 1210 CONTINUE
      GOTO 1180
 1220 CONTINUE
C
```

```
C     CALCULATE THE EFFECTIVE ULTRAVIOLET IRRADIANCE ACCORDING TO ANY OF
C     THE THREE ACTION SPECTRA(SLAMBD,ULAMBD,ALAMBD) THROUGH EITHER FILTER
C     OR BOTH FILTERS.  THERE ARE NINE POSSIBLE QUANTITIES TO CALCULATE
C     AND THE ONES TO BE CALCULATED ARE SPECIFIED ON INPUT BY FILCAL
C
      DO 1320 I = 1,9
      CAL = FILCAL(I)+1
      GOTO(1320,1230,1240,1250,1260,1270,1280,1290,1300,1310),CAL
 1230 CALL FILSUB(FILTER,CAL,ELAMBD,FT1,SLAMBD,DELTA,$1320)
 1240 CALL FILSUB(FILTER,CAL,ELAMBD,FT1,ULAMBD,DELTA,$1320)
 1250 CALL FILSUB(FILTER,CAL,ELAMBD,FT1,ALAMBD,DELTA,$1320)
 1260 CALL FILSUB(FILTER,CAL,ELAMBD,FT2,SLAMBD,DELTA,$1320)
 1270 CALL FILSUB(FILTER,CAL,ELAMBD,FT2,ULAMBD,DELTA,$1320)
 1280 CALL FILSUB(FILTER,CAL,ELAMBD,FT2,ALAMBD,DELTA,$1320)
 1290 CALL FILSUM(FILTER,CAL,ELAMBD,FT1,FT2,SLAMBD,DELTA,$1320)
 1300 CALL FILSUM(FILTER,CAL,ELAMBD,FT1,FT2,ULAMBD,DELTA,$1320)
 1310 CALL FILSUM(FILTER,CAL,ELAMBD,FT1,FT2,ALAMBD,DELTA,$1320)
 1320 CONTINUE
 1330 CONTINUE
C
C               ***********************************************
      IDELTA = IFIX(DELTA(2))
      WRITE(15,1331) EVENT,MAXELM,IDELTA
 1331 FORMAT(3A6,I4,I2)
      DO 1333 I = 1,MAXELM
          WRITE(15,1332) ELAMBD(I,1)
 1332     FORMAT(F5.0)
 1333 CONTINUE
      DO 1335 I = 1,MAXELM
          WRITE(15,1334) ELAMBD(I,2)
 1334     FORMAT(E9.4)
 1335 CONTINUE
C               ***********************************************
C
C
C     PRINT THE TABLE DATA---MUST DETERMINE IF THERE IS FILTER DATA AND
C     IF THERE IS A GENERAL WEIGHTING DATA TO BE PRINTED AND IF FILTER
C     DATA IS TO BE PRINTED WHETHER IT IS ONE OR TWO FILTERS
C
      CALL DATEIM(DATE)
      PEAK = 0
      PAGE = 0
      LYNE=58
      LINMAX = 57
      K = 1
      IF(GENWEI .GT. 0) K = 2
      K = K + NUMFIL * 2
      GOTO(1340,1370,1400,1430,1460,1490),K
C
C     PRINT TABLE WITH NO GENERAL WEIGHTING AND NO FILTER DATA
C
 1340 K = 1
      DO 1360 I = 1,MAXELM
      CALL PRTCON
      CFRES = SEQUEN(EINSTR,I,CF,K)
      PRINT 1350,EINSTR(I,1),CFRES,EINSTR(I,2),EIFOFX(I,2),ELAMBD(I,2),
     1          LLAMBD(I,2),ERETLB(I,2),ERETLB(I,3)
```

```
 1350 FORMAT('0',T2,F5.0,T8,7(1PE9.4,2X))
 1360 CONTINUE
      GOTO 1515
C
C     PRINT TABLE WITH GENERAL WEIGHTING DATA, NO FILTER DATA
C
 1370 K = 1
      DO 1390 I = 1,MAXELM
      CALL PRTCON
      CFRES = SEQUEN(EINSTR,I,CF,K)
      PRINT 1380,EINSTR(I,1),CFRES,EINSTR(I,2),EIFOFX(I,2),ELAMBD(I,2),
     1 LLAMBD(I,2),(ERETLB(I,J),J=2,3),GLAMBD(I,2)
 1380 FORMAT('0',F5.0,T8,8(1PE9.4,2X))
 1390 CONTINUE
      GOTO 1515
C
C     PRINT TABLE WITH ONE FILTER AND NO GENERAL WEIGHTING DATA
C
 1400 K = 1
      DO 1420 I = 1,MAXELM
      CALL PRTCON
      CFRES = SEQUEN(EINSTR,I,CF,K)
      PRINT 1410,EINSTR(I,1),CFRES,EINSTR(I,2),EIFOFX(I,2),ELAMBD(I,2),
     1 LLAMBD(I,2),(ERETLB(I,J),J=2,3),EFT(I,2)
 1410 FORMAT('0',F5.0,T8,7(1PE9.4,2X),T96,1PE9.4)
 1420 CONTINUE
      GOTO 1515
C
C     PRINT TABLE WITH GENERAL WEIGHTING AND ONE FILTER
C
 1430 K = 1
      DO 1450 I = 1,MAXELM
      CALL PRTCON
      CFRES = SEQUEN(EINSTR,I,CF,K)
      PRINT 1440,EINSTR(I,1),CFRES,EINSTR(I,2),EIFOFX(I,2),ELAMBD(I,2),
     1 LLAMBD(I,2),(ERETLB(I,J),J=2,3),GLAMBD(I,2),EFT(I,2)
 1440 FORMAT('0',F5.0,T8,9(1PE9.4,2X))
 1450 CONTINUE
      GOTO 1515
C
C     PRINT TABLE WITH TWO FILTERS AND NO GENERAL WEIGHTING DATA
C
 1460 K = 1
      DO 1480 I = 1,MAXELM
      CALL PRTCON
      CFRES = SEQUEN(EINSTR,I,CF,K)
      PRINT 1470,EINSTR(I,1),CFRES,EINSTR(I,2),EIFOFX(I,2),ELAMBD(I,2),
     1 LLAMBD(I,2),(ERETLB(I,J),J=2,3),(EFT(I,L),L=2,4)
 1470 FORMAT('0',F5.0,T8,7(1PE9.4,2X),T96,3(E9.4,2X))
 1480 CONTINUE
      GOTO 1515
C
C     PRINT TABLE WITH GENERAL WEIGHTING AND BOTH FILTERS
C
 1490 K = 1
      DO 1510 I = 1,MAXELM
      CALL PRTCON
```

```
      CFRES = SEQUEN(EINSTR,I,CF,K)
      PRINT 1500,EINSTR(I,1),CFRES,EINSTR(I,2),EIFOFX(I,2),ELAMBD(I,2),
     1 LLAMBD(I,2),(ERETLB(I,J),J=2,3),BLAMBD(I,2),(EFT(I,L),L=2,4)
 1500 FORMAT('0',F5.0,T8,11(1PE9.4,2X))
 1510 CONTINUE
 1515 PRINT 1520
 1520 FORMAT('1')
      PAGE=PAGE+1
      PRINT 6010,DATE,PAGE
      PRINT 6020,DESCRP
      PRINT 6025,EVENT,OMEGA
 6025 FORMAT(T2,'SOURCE DESCRIPTION:  ',
     A 3A6,'.   SOLID ANGLE = ',E9.2)
      IF (ITEST .EQ. 0) GOTO 6130
      GOTO (6131,6132,6133),ITEST
 6130 PRINT 6030
      GOTO 6040
 6131 PRINT 6031
      GOTO 6040
 6132 PRINT 6032
      GOTO 6040
 6133 PRINT 6033
 6010 FORMAT(T2,'LMD SPECTRAL WEIGHTING PROGRAM',T90,'DATE ',2A6,
     1 T110,'PAGE ',I3)
C
 6020 FORMAT('0',T2,13A6,A2/T2,13A6,A2)
C
 6030 FORMAT(//T45,'SUMMARIZATION SHEET FOR SOURCE',
     A      /,T2,120('-'))
 6031 FORMAT(//T37,'SUMMARIZATION SHEET FOR SOURCE
     A WITH FILTER ONE',/,T2,120('-'))
 6032 FORMAT(//T37,'SUMMARIZATION SHEET FOR SOURCE
     A WITH FILTER TWO',/,T2,120('-'))
 6033 FORMAT(//T30,'SUMMARIZATION SHEET FOR SOURCE
     A WITH FILTERS ONE AND TWO',/,T2,120('-'))
 6040 PRINT 1650,EDELLB
      PRINT 1655,LDELLB
      PRINT 1660,ACGIH
      PRINT 1670,CIE
      PRINT 1680,ANSI
      PRINT 1690,BLUHAZ
      PRINT 1700,XBAR
      PRINT 1710,YBAR
      PRINT 1720,ZBAR
      PRINT 1730,P445
      PRINT 1740,P535
      PRINT 1750,P575
      PRINT 1760,VE
      PRINT 1770,VIE
      PRINT 1780,TRANS
      PRINT 1790,TRANTX
      PRINT 1800,EECA
      PRINT 1810,PCTUV
      PRINT 1820,PCTVI
      PRINT 1830,PCTNIR
C
C     PRINT FILTER DATA IF PRESENT
```

```
      C
            IF(NUMFIL .EQ. 0) GOTO 1645
            PRINT 1840,EEF1
            GOTO(1540,1530),NUMFIL
       1530 PRINT 1850,EEF2
            PRINT 1860,EEFIG2
       1540 DO 1640 I = 1,3
            IF(FILCAL(I) .EQ. 0) GOTO 1645
            M = FILCAL(I)
            GOTO(1550,1560,1570,1580,1590,1600,1610,1620,1630),M
       1550 PRINT 1870,LAMBDA(1),FLTCNT(1),FILTER(1)
            GOTO 1640
       1560 PRINT 1870,LAMBDA(2),FLTCNT(1),FILTER(2)
            GOTO 1640
       1570 PRINT 1870,LAMBDA(3),FLTCNT(1),FILTER(3)
            GOTO 1640
       1580 PRINT 1870,LAMBDA(1),FLTCNT(2),FILTER(4)
            GOTO 1640
       1590 PRINT 1870,LAMBDA(2),FLTCNT(2),FILTER(5)
            GOTO 1640
       1600 PRINT 1870,LAMBDA(3),FLTCNT(2),FILTER(6)
            GOTO 1640
       1610 PRINT 1870,LAMBDA(1),FLTCNT(3),FILTER(7)
            GOTO 1640
       1620 PRINT 1870,LAMBDA(2),FLTCNT(3),FILTER(8)
            GOTO 1640
       1630 PRINT 1870,LAMBDA(3),FLTCNT(3),FILTER(9)
       1640 CONTINUE
       1645 PRINT 1880,ILLUM
            PRINT 1890,LUMIN
            IF (NUMFIL .EQ. 0) GOTO 1646
            IF (ITEST .EQ. 0) GOTO 1041
            GOTO (1042,1043),ITEST
       1646 CALL INITIL
            GOTO 530
       1650 FORMAT('0 TOTAL SPECTRAL IRRADIANCE FOR THE WAVELENGTH LIMITS USED
           1 FOR THE INSTRUMENT READINGS',T100,1PE9.4)
       1655 FORMAT('0 TOTAL RADIANCE OF SOURCE FROM LAMBDA-MIN TO LAMBDA-MAX'
           1          ,T100,1PE9.4)
       1660 FORMAT('0 EFFECTIVE ULTRAVIOLET IRRADIANCE ACCORDING TO THE ACGIH
           1STANDARD ACTION SPECTRUM',T100,1PE9.4)
       1670 FORMAT('0 EFFECTIVE ULTRAVIOLET IRRADIANCE ACCORDING TO 1936 CIE U
           1LTRAVIOLET ERYTHEMA ACTION SPECTRUM',T100,1PE9.4)
       1680 FORMAT('0 EFFECTIVE ULTRAVIOLET IRRADIANCE ACCORDING TO ANSI-Z136
           1LASER WEIGHTING UV HAZARD FUNCTION',T100,1PE9.4)
       1690 FORMAT('0 BLUE LIGHT HAZARD FUNCTION WEIGHTED AGAINST SPECTRAL IRR
           1ADIANCE',T100,1PE9.4)
       1700 FORMAT('0 1931 BLUE CHROMATICITY COORDINATES WEIGHTED AGAINST SPEC
           1TRAL IRRADIANCE',T100,1PE9.4)
       1710 FORMAT('0 1931 GREEN CHROMATICITY COORDINATES WEIGHTED AGAINST SPE
           1CTRAL IRRADIANCE',T100,1PE9.4)
       1720 FORMAT('0 1931 RED CHROMATICITY COORDINATES WEIGHTED AGAINST SPECT
           1RAL IRRADIANCE',T100,1PE9.4)
       1730 FORMAT('0 DARTNALL NOMOGRAM ABSORPTION COEFFICIENT FOR BLUE  WEIGH
           1TED AGAINST SPECTRAL IRRADIANCE',T100,1PE9.4)
       1740 FORMAT('0 DARTNALL NOMOGRAM ABSORPTION COEFFICIENT FOR GREEN WEIGH
           1TED AGAINST SPECTRAL IRRADIANCE',T100,1PE9.4)
```

```
      1750 FORMAT('0 DARTNALL NOMOGRAM ABSORPTION COEFFICIENT FOR  RED  WEIGH
     1TED AGAINST SPECTRAL IRRADIANCE',T100,1PE9.4)
      1760 FORMAT('0 RADIANT EFFICACY (LUMENS/WATT) OF RADIATION FROM LAMBDA-
     1MIN TO LAMBDA-MAX',T100,1PE9.4)
      1770 FORMAT('0 FACTION CIE SCOTOPIC RADIATION FROM LAMBDA-MIN TO LAMBDA
     1-MAX',T100,1PE9.4)
      1780 FORMAT('0 EFFECTIVE TRANSMISSION OF OCULAR MEDIA FROM LAMBDA-MIN T
     1O LAMBDA-MAX',T100,1PE9.4)
      1790 FORMAT('0 EFFECTIVE TRANSMISSION OF OCULAR MEDIA MULTIPLIED BY SPE
     1CTRAL ABSORPTION OF OCULAR MEDIA',T100,1PE9.4)
      1800 FORMAT('0 ANSI LASER MPE WEIGHTING FACTOR FOR VISIBLE AND INFRARED
     1-A',T100,1PE9.4)
      1810 FORMAT('0 PERCENT OF TOTAL IRRADIANCE BETWEEN LAMBDA-MIN AND LAMBD
     1A-MAX WHICH IS ULTRAVIOLET RADIATION',T100,1PE9.4)
      1820 FORMAT('0 PERCENT OF TOTAL IRRADIANCE BETWEEN LAMBDA-MIN AND LAMBD
     1A-MAX WHICH IS VISIBLE RADIATION',T100,1PE9.4)
      1830 FORMAT('0 PERCENT OF TOTAL IRRADIANCE BETWEEN LAMBDA-MIN AND LAMBD
     1A-MAX WHICH IS NEAR INFRARED RADIATION',T100,1PE9.4)
      1840 FORMAT('0 TOTAL SPECTRAL IRRADIANCE WEIGHTED SPECTRALLY AGAINST TH
     1E TRANSMISSION OF FILTER ONE',T100,1PE9.4)
      1850 FORMAT('0 TOTAL SPECTRAL IRRADIANCE WEIGHTED SPECTRALLY AGAINST TH
     1E TRANSMISSION OF FILTER TWO',T100,1PE9.4)
      1860 FORMAT('0 TOTAL SPECTRAL IRRADIANCE WEIGHTED SPECTRALLY AGAINST TH
     1E TRANSMISSION OF BOTH FILTERS',T100,1PE9.4)
      1870 FORMAT('0 EFFECTIVE UV IRRADIANCE ACCORDING TO ',2A4, ' ACTION SPE
     1CTRA THROUGH ', A6,T100,1PE9.4)
      1880 FORMAT('0 ILLUMINANCE IN LUMENS PER SQUARE CENTIMETER',T100,1PE9.4
     1)
      1890 FORMAT('0 LUMINANCE IN CANDELAS PER SQUARE CENTIMETER',T100,1PE9.4
     1)
      9999 END FILE 15
           REWIND 15
           CALL HPLOT
           PRINT 1900
      1900 FORMAT('1',' ALL PROCESSING COMPLETED')
           STOP
C
C                                   ***************************
C                                   *                         *
C                                   *   END OF MAIN PROGRAM   *
C                                   *                         *
C                                   *   SUBROUTINES FOLLOW    *
C                                   *                         *
C                                   ***************************
C
C                                   ***************************
C                                   *                         *
C                                   *   SUBROUTINE   IDENT    *
C                                   *                         *
C                                   ***************************
C
C
C      PRINT OUT THE INPUT PARAMETERS CONVERTING TO
C       NARRATIVE WHEN POSSIBLE
C
C
C
```

```
      SUBROUTINE IDENT
      DIMENSION FILTAB(10,7),CALTAB(2,3),GFTAB(16,4)
      INTEGER FILTAB
      INTEGER CALTAB
      INTEGER GFTAB
      DATA ((FILTAB(IT,JT),JT=1,7),IT=1,10)/
     A'NO FIL','TER CA','LCULAT','ION   ','      ','      ','      ',
     1'E-LAMB','DA*FIL','TER1*S','LAMBDA','*DELTA','      ','      ',
     2'E-LAMB','DA*FIL','TER1*U','-LAMBD','A*DELT','A     ','      ',
     3'E-LAMB','DA*FIL','TER1*A','-LAMBD','A*DELT','A     ','      ',
     4'E-LAMB','DA*FIL','TER2*S','-LAMBD','A*DELT','A     ','      ',
     5'E-LAMB','DA*FIL','TER2*U','-LAMBD','A*DELT','A     ','      ',
     6'E-LAMB','DA*FIL','TER2*F','-LAMBD','A*DELT','A     ','      ',
     7'E-LAMB','DA*FIL','TER1*F','ILTER2','*J-LAB','BDA*DE','LTA   ',
     8'E-LAMB','DA*FIL','TER1*F','ILTER2','*U-LAB','BDA*DE','LTA   ',
     9'E-LAMB','DA*FIL','TER1*F','ILTER2','*F-LAB','BDA*DE','LTA   '/
      DATA ((CALTAB(IC,JC),JC=1,3),IC=1,2) /
     1'RAW DA','TA    ','      ',
     2'CALCUL','ATED D','ATA   '/
      DATA ((GFTAB(IG,JG),JG=1,4),IG=1,16) /
     1'WEIGHT','ING FN',' IN PR','OGRAM ',
     2'ELAMBD','A*S-LA','MBDA  ','      ',
     3'ELAMBD','A*U-LA','MBDA  ','      ',
     4'ELAMBD','A*A-LA','MBDA  ','      ',
     5'ELAMBD','A*T-LA','MBDA  ','      ',
     6'ELAMBD','A*TA-L','AMBDA ','      ',
     7'ELAMBD','A*CA-L','AMBDA ','      ',
     8'ELAMBD','A*U-LA','MBDA  ','      ',
     9'ELAMBD','A*VP-L','AMBDA ','      ',
     A'ELAMBD','A*B-LA','MBDA  ','      ',
     B'ELAMBD','A*XBAR','-LAMBD','A     ',
     C'ELAMBD','A*YBAR','-LAMBD','A     ',
     D'ELAMBD','A*ZBAR','-LAMBD','A     ',
     E'ELAMBD','A*P445','-LAMBD','A     ',
     F'ELAMBD','A*P535','-LAMBD','A     ',
     G'ELAMBD','A*P575','-LAMBD','A     '/
 6000 FORMAT(1H1,T5,' DESCRIPTION : ',13A6,A2/,T30,13A6,A2,/)
 6010 FORMAT(T20,'NOCOF1 = ',I2,'  CALCULATED
     ADATA USED FOR FILTER ONE'/)
 6011 FORMAT(T20,'NOCOF1 = ',I2,'  RAW DATA USED FOR FILTER ONE'/)
 6012 FORMAT(T20,'NOCOF2 = ',I2,'  CALCULATED
     A DATA USED FOR FILTER TWO'/)
 6013 FORMAT(T20,'NOCOF2 = ',I2,'  RAW DATA USED FOR FILTER TWO'/)
 6001 FORMAT(T20,'NUMBER OF FILTERS USED = ',I2,/)
 6020 FORMAT(T20,'CALDAT = ',I2,'  CALIBRATION INPUT IS RAW DATA'/)
 6021 FORMAT(T20,'CALDAT = ',I2,'  CALIBRATION INPUT IS CALCULATED DATA
     A'/)
 6022 FORMAT(T20,'CALDAT = ',I2,'  NO CALIBRATION INPUT, TABLE SET TO ',
     A                           'ONES'/)
 6030 FORMAT(T20,'GENFUN = ',I2,'  GENERAL FUNCTION IS IN COMPUTER'
     A                           ' PROGRAM'/)
 6031 FORMAT(T20,'GENFUN = ',I2,'  READ INTO COMPUTER THE GENERAL FUNCTI
     AON DATA'/)
 6040 FORMAT(T20,7A6)
 6050 FORMAT(T20,4A6)
 6060 FORMAT (T20,'ULTRAVIOLET DISTANCE = ',F9.2/,
     A          T20,'VISIBLE LIGHT DISTANCE = ',F9.2)
```

```
C
C
C
C PRINT DESCRIPTION
      PRINT 6000,(DESCRP(I),I=1,28)
C PRINT NUMBER OF FILTERS USED
      PRINT 6001,NUMFIL
C PRINT CALCULATED/RAW FILTER DATA
      IF (NOCOF1 .EQ. 1) GO TO 10
      PRINT 6011,NOCOF1
      GO TO 20
 10   CONTINUE
      PRINT 6010,NOCOF1
   20 IF (NUMFIL .EQ. 1) GOTO 25
      IF (NOCOF2 .EQ. 1) GOTO 11
      PRINT 6013,NOCOF2
      GOTO 25
   11 PRINT 6012,NOCOF2
C PRINT FILTER CALIBRATION FROM FILTAB
   25 IX=FILCAL+1
      PRINT 6040, (FILTAB(IX,IY),IY=1,7)
C PRINT DATA TYPE
      ICAL=CALDAT+1
      GO TO (30,31,33),ICAL
 31   CONTINUE
      PRINT 6021,CALDAT
      PRINT 6023,CALHDR
 6023 FORMAT(T20,'CALIBRATION :   ',13A6,A2)
      GO TO 40
  30  CONTINUE
      PRINT 6020,CALDAT
      PRINT 6023,CALHDR
      GO TO 40
 33   CONTINUE
      PRINT 6022,CALDAT
 40   CONTINUE
C PRINT GENERAL WEIGHTING TABLE
      IX=GENWEI+1
      PRINT 6050,(GFTAB(IX,IY),IY=1,4)
C PRINT GENERAL FUNCTION
      IF(GENFUN .EQ. 0) GO TO 50
      PRINT 6031,GENFUN
      PRINT 6069,FWAVE,LWAVE
      PRINT 6070,DATA
      GO TO 60
 50   CONTINUE
      PRINT 6030,GENFUN
 60   CONTINUE
C
      PRINT 6060,DFU,DFV
 6069 FORMAT(T20,'FOR WAVELENGTHS ',I4,' TO ',I4)
 6070 FORMAT(T20,'GENERAL FUNCTION VALUE IS ',E9.2)
      RETURN
C
C                          ***************************
C                          *                         *
C                          *  SUBROUTINE   INITIL    *
```

```
C                                   *                         *
C                                   ***************************
C
      SUBROUTINE INITIL
C
C     THIS SUBROUTINE INITIALIZES MAIN PROGRAM VARIABLES
C
      DO 20 I = 1,2
         DO 10 J = 1,340
            EINSTR(J,I) = 0
            EIFOFX(J,I) = 0
            ELAMBD(J,I) = 0
            LLAMBD(J,I) = 0
            ERETLB(J,I) = 0
            GLAMBD(J,I) = 0
   10    CONTINUE
   20 CONTINUE
      DO 40 I = 1,4
         DO 30 J = 1,340
            EFT(J,I) = 0
   30    CONTINUE
   40 CONTINUE
      DO 50 I = 1,340
         ERETLB(I,3) = 0
         DELTA(I) = 0
   50 CONTINUE
      DO 60 I = 1,9
         FILTER(I) = 0
   60 CONTINUE
      RETURN
C
C                                   ***************************
C                                   *                         *
C                                   *   SUBROUTINE INTERP     *
C                                   *                         *
C                                   ***************************
C
      SUBROUTINE INTERP(X,Y,I,J,Z)
C
C     THIS SUBROUTINE INTEPOLES THE DATA IN ARRAY Y TO CORRESPOND TO ARRAY
C     X AND PUTS THE RESULT IN Z
C
      REAL X(340,2)
      REAL Y(340,2)
      A = Y(J,1) - Y(J-1,1)
      B = Y(J,2) - Y(J-1,2)
      C = B / A
      D = X(I,1) - Y(J-1,1)
      E = D * C
      Z = Y(J-1,2) + E
      RETURN
C
C                                   ***************************
C                                   *                         *
C                                   *      FUNCTION SUM       *
C                                   *                         *
C                                   ***************************
```

```
C
      REAL FUNCTION SUM(E,X,D)
C
C     THIS FUNCTION SUMS THE PRODUCTS OF EACH ELEMENT OF E,X,D ARRAYS
C
      DIMENSION  E(340,2),
     1           X(340,2),
     2           D(340)
      K = 1
      SUM = 0
      DO 50 I = 1,MAXELM
      IF(E(I,1) .LT. O) GOTO 50
      IF(E(I,1) .LT. X(1,1)) GOTO 50
   10 IF(E(I,1) .EQ. X(K,1)) GOTO 30
      IF(E(I,1) .LT. X(K,1)) GOTO 20
      K = K + 1
      GOTO 10
   20 CALL INTERP(E,X,I,K,R)
      GOTO 40
   30 R = X(K,2)
   40 SUM = SUM + E(I,2) * R * D(I)
   50 CONTINUE
      K = 1
      DO 80 I = 1,MAXELM
      IF(E(I,1) .GE. O) GOTO 80
      DO 60 J = K,MAXELM
      IF(E(I,1) .LT. X(J,1)) GOTO 70
   60 CONTINUE
   70 K = J
      R = X(K,2)
      IF(E(I,1) .NE. X(K,1)) CALL INTERP(E,X,I,K,R)
      CONT = E(I,2) - E(I-1,2)
      IF((E(I,1) - E(I-1,1)) .EQ. (E(I+1,1) - E(I,1))) CONT = (E(I+1,2)
     1 +  E(I-1,2)) / 2
      SUM = SUM + CONT * R * D(I-1)
      PK = E(I,2) - CONT
      SUM = SUM + PK * R * D(I)
   80 CONTINUE
      RETURN
C
C                                ***************************
C                                *                         *
C                                *      FUNCTION SUM1      *
C                                *                         *
C                                ***************************
C
      REAL FUNCTION SUM1(E,D,L,H)
C
C     THIS FUNCTION SUMS THE PRODUCTS OF EACH ELEMENT OF E,D ARRAYS
C
      DIMENSION E(340,2),
     1          D(340)
      INTEGER L,H
      SUM1 = 0
      DO 10 I = L,H
      IF(E(I,1) .LT.O) GOTO 10
      SUM1 = SUM1 + E(I,2) * D(I)
```

```
   10 CONTINUE
      DO 20 I = L,H
      IF(E(I,1) .GT. 0) GOTO 20
      CONT = E(I,2) - E(I-1,2)
      IF((E(I,1) - E(I-1,1)) .EQ. (E(I+1,1) - E(I,1))) CONT = (E(I+1,2)
     1 + E(I-1,2)) / 2
      SUM1 = SUM1 + CONT * D(I-1)
      PK = E(I,2) - CONT
      SUM1 = SUM1 + PK * D(I)
   20 CONTINUE
      RETURN
C
C                                 ***************************
C                                 *                         *
C                                 *   SUBROUTINE GLAMCO     *
C                                 *                         *
C                                 ***************************
C
      SUBROUTINE GLAMCO(R,X,Y,$)
C
C     SUBROUTINE MULTIPLIES EACH ELEMENT IN X WITH ITS CORRESPONDING
C     ELEMENT IN Y PUTTIN IT IN ARRY R
C
      DIMENSION R(340,2),
     1          X(340,2),
     1          Y(340,2)
      K = 1
      DO 50 I = 1,MAXELM
   10 IF(X(I,1) .EQ.Y(K,1)) GOTO 30
      IF(X(I,1) .LT.Y(K,1)) CCTO 20
      K = K + 1
      GOTO 10
   20 CALL INTERP(X,Y,I,K,Z)
      GOTO 40
   30 Z = Y(K,2)
   40 R(I,1) = X(I,1)
      R(I,2) = X(I,2) * Z
   50 CONTINUE
      J=4
      RETURN J
C                                 ***************************
C                                 *                         *
C                                 *   SUBROUTINE FILSUM     *
C                                 *                         *
C                                 ***************************
C
C
      SUBROUTINE FILSUM(R,N,X,Y,Y1,Z,D,$)
C
C     THIS SUBROUTINE SUMS THE PRODUCTS OF EACH ELEMENT OF X,Y,Y1,Z,C ARRAYS
C
C
      DIMENSION R(340,2),
     1          X(340,2),
     2          Y(340,2),
     3         Y1(340,2),
     4          Z(340,2),
```

```
     5              D(340),
     7           RLS(340,2),
     6              T(340,2)
      DO 10 I = 1,340
      IF(Y(I,1) .EQ. D) GOTO 20
      T(I,1) = Y(I,1)
      T(I,2) = Y(I,2) * Y1(I,2)
   10 CONTINUE
   20 L = 8
      GOTO 30
      ENTRY FILSUB(R,N,X,T,Z,D,$)
      L = 7
   30 N = N - 1
      R(N) = 0
      J = 1
      K = 1
      DO 110 I = 1,MAXELM
   40 IF(ABS(X(I,1)) .EQ. T(K,1)) GOTO 60
      IF(ABS(X(I,1)) .LT. T(K,1)) GOTO 50
      K = K +1
      GOTO 40
   50 CALL INTERP(X,T,I,K,A)
      GOTO 70
   60 A = T(K,2)
   70 IF(ABS(X(I,1)) .EQ. Z(J,1)) GOTO 90
      IF(ABS(X(I,1)) .LT. Z(J,1)) GOTO 80
      J = J +1
      GOTO 70
   80 CALL INTERP(X,Z,I,J,B)
      GOTO 100
   90 B = Z(J,2)
  100 RLS(I,1) = ABS(X(I,1))
      RLS(I,2) = A * B
  110 CONTINUE
      R(N) = SUM(X,RLS,D)
      RETURN L
C
C                                  ***********************
C                                  *                     *
C                                  *   FUNCTION SEQUEN   *
C                                  *                     *
C                                  ***********************
C
      REAL FUNCTION SEQUEN(X,I,Y,J)
C
C     THIS FUNCTION RETURNS THE VALUE IN Y(I,2) FOR WHICH Y(I,1) MATCHES X(I,1)
C
      DIMENSION X(340,2),
     1          Y(340,2)
   10 IF(X(I,1) .EQ. Y(J,1)) GOTO 20
      IF(X(I,1) .LT. Y(J,1)) GOTO 30
      J = J + 1
      GOTO 10
   20 SEQUEN = Y(J,2)
      GOTO 40
   30 CALL INTERP(X,Y,I,J,SEQUEN)
   40 RETURN
```

```
C
C                                  ************************
C                                  *                      *
C                                  *  SUBROUTINE PRTCON   *
C                                  *                      *
C                                  ************************
C
      SUBROUTINE PRTCON
C
C     CONTROL THE PRINTING OF THE LISTING
C
      LYNE = LYNE + 2
      IF(PEAK .EQ. 0) GOTO 20
      PRINT 10
   10 FORMAT('0',34('*')//)
      LYNE = LYNE + 4
      PEAK = 0
   20 IF(LYNE .LT. LINMAX) GOTO 30
      PAGE = PAGE + 1
      CALL HEADIN
      LYNE = 12
   30 IF(EINSTR(I,1) .GT. 0) GOTO 60
      IF((LYNE + 6) .LT. LINMAX) GOTO 40
      PAGE = PAGE + 1
      CALL HEADIN
   40 PRINT 50
   50 FORMAT('0'//10('*'),5(' '),'PEAK',5(' '),10('*'))
      LYNE = LYNE + 4
      EINSTR(I,1) = ABS(EINSTR(I,1))
      PEAK = 1
   60 RETURN
C
C                                  ************************
C                                  *                      *
C                                  *  SUBROUTINE HEADIN   *
C                                  *                      *
C                                  ************************
C
      SUBROUTINE HEADIN
C
C     PRINTS THE PAGE HEADING
C
      PRINT 10,DATE,PAGE
      PRINT 20,DESCRP
      PRINT 30,EVENT
      PRINT 35,OMEGA
   35 FORMAT(' SOURCE SOLID ANGLE IS ',E9.2)
      PRINT 40
      PRINT 50
      PRINT 60,(PRTLAM(GENWEI+1,I),I=1,3)
      PRINT 70
   10 FORMAT('1',T2,'LMD SPECTRAL WEIGHTING PROGRAM',T90,'DATE ',2A6,
     1T110,'PAGE ',I3)
   20 FORMAT('0',T2,13A6,A2/T2,13A6,A2)
   30 FORMAT(' ',T2,3A6)
   40 FORMAT('0',T31, 'ADJUSTED   SPECTRAL   SPECTRAL      SPECTRAL-RETIN
     1AL     GENERAL      SPECTRAL FILTER TRANSMISSIONS')
```

```
      50 FORMAT(' ',T3,'WAVE    CALIBRAT   INSTRUMENT INSTRUMENT IRRADIANCE
        1RADIANCE        IRRADIANCE          WEIGHTING       FILTER     FILTER
        2  FILTER')
      60 FORMAT(' ',T2,'LENGTH    FACTOR     READINGS    READINGS     SOURCE
        1  SOURCE      (3-MM)       (7-MM)  ',2A6,A2,T100,'ONE              TWO      O
        2NE , TWO')
      70 FORMAT(' ',T2,'----',11(2X,9('-')))
         RETURN
C
C                                   *************************
C                                   *                       *
C                                   *   SUBROUTINE BDREAD   *
C                                   *                       *
C                                   *************************
C
         SUBROUTINE BDREAD(TABLE)
C
C        SUBROUTINE READS BIODECK DATA THAT IS ON SEPARATE CARDS
C
         DIMENSION TABLE(340,2)
         DO 20 I = 1,340
         READ(5,10,ERR=30)(TABLE(I,J),J=1,2)
      10 FORMAT(F4.0,T9,E9.2)
      20 CONTINUE
         GOTO 50
      30 READ(0,40) M
      40 FORMAT(A3)
         IF(M .EQ. 'END') GOTO 70
      50 PRINT 60
      60 FORMAT('0 BIODECK DID NOT END CORRECTLY')
         STOP
      70 RETURN
C
C                                   *************************
C                                   *                       *
C                                   *    SUBROUTINE HPLOT   *
C                                   *                       *
C                                   *************************
C
         SUBROUTINE HPLOT
C
C        SUBROUTINE CREATES CALCOMP PLOT TAPE
C
         DIMENSION  XAXIS(685),YAXIS(685),IBUF(5000)
         INTEGER EVENT(3)
         CALL PLOTS(IBUF,5000,20)
         CALL PLOT(0.,-36.,-3)
         CALL PLOT(0.,2.,-3)
         CALL SYMBOL(0.,0.,0.21,17HAEHA,X2475,LMDSWP,90.,17)
         CALL PLOT(2.,-0.8,-3)
         NPLOT = 0
       4 READ(15,10,END=999) EVENT,ISIZE,INCREM,FIG,CM
      10 FORMAT(3A6,I4,I2,A2,A5)
         EVENT2(10)=EVENT(1)
         EVENT2(11)=EVENT(2)
         EVENT2(12)=EVENT(3)
         READ(15,20) XAXIS(1)
```

```
   20 FORMAT(F5.0)
      L=2
      K=3
      IDELTA = INCREM/2
      DO 30 I=2,ISIZE
      READ(15,20) XAXIS(L)
      XAXIS(L)=XAXIS(L)-IDELTA
      XAXIS(K)=XAXIS(L)
      L = L+ 2
      K = K + 2
   30 CONTINUE
      XAXIS(L) = XAXIS(K-2) + INCREM
      ISIZE = ISIZE*2
      DO 50 I = 1,ISIZE,2
      READ(15,40) YAXIS(I)
   40 FORMAT(E9.4)
      YAXIS(I+1)=YAXIS(I)
   50 CONTINUE
      IF (NPLOT .EQ. 0) GOTO 5                            @ FIRST PLOT
   63 IF (MOD(NPLOT,4) .EQ. 0) GOTO 60                    @ NEW STACK OF PLOTS
      CALL PLOT(-0.79,7.1,-3)
      GOTO 5
   60 CALL PLOT(10.15,-36.,-3)
      CALL PLOT(0.,1.2,-3)
    5 NPLOT = NPLOT + 1
C     DRAW BORDER, HAVING ESTABLISHED LOWER LEFT CORNER
      CALL PLOT(0.,8.,2)
      CALL PLOT(10.5,8.,2)
      CALL PLOT(10.5,0.,2)
      CALL PLOT(0.,0.,2)
      CALL PLOT(0.79,1.3,-3)                              @ ORIGIN OF AXES
C     LABEL GRAPH
      CALL SYMBOL(0.,-0.9,0.14,EVENT2,0.,72)
      CALL SYMBOL(0.98,-0.9,0.14,FIG,0.,2)
      CALL SYMBOL(6.16,-0.9,0.14,CM,0.,5)
C     DRAW,NUMBER,LABEL X-AXIS
      CALL PLOT(0.,0.,3)
      CALL PLOT(9.,0.,2)
      DO 55 I=1,11
      X = (I-1) * 0.9
      CALL PLOT(X,0.,3)
      CALL PLOT(X,-0.06,2)
      X = X - 0.07
      FPN = (I+1) * 100.
   55 CALL NUMBER(X,-0.26,0.14,FPN,0.,-1)
      CALL SYMBOL(3.5,-0.48,0.14,15HWAVELENGTH (NM),0.,15)
C     SET PARAMETERS FOR LINE GRAPH
      XAXIS(ISIZE+1) = 200.
      XAXIS(ISIZE+2) = 100. * 10./9.
C      Y-AXIS ROUTINES
C     ISIZE JOCKEYED TO ELIMINATE REDUNDANT SCALING
      ISIZE = ISIZE/2
      IF (MOD(NPLOT,2) .EQ. 0) GOTO 61
      CALL SCALE(YAXIS,6.,ISIZE,2)                        @ LINEAR
      ISIZE = ISIZE*2
      YAXIS(ISIZE+2) = YAXIS(ISIZE+3)
      CALL AXIS(0.,0.,30HSPECTRAL IRRADIANCE (W/CM /NM),
```

```
     A   30,6.,90.,YAXIS(ISIZE+1),YAXIS(ISIZE+2))
       CALL SYMBOL(-0.36,3.94,0.07,1H2,90.,1)
       CALL LINE(XAXIS,YAXIS,ISIZE,1,0,0)
       GOTO 63
    61 CALL SCALG(YAXIS,6.,ISIZE,2)                    @ LOGARITHMIC
       ISIZE = ISIZE*2
     C DRAW,LABEL Y-AXIS
       CALL PLOT(0.,0.,3)
       CALL PLOT(0.,6.,2)
       CALL SYMBOL(-0.43,0.9,0.14,30HSPECTRAL IRRADIANCE (W/CM /NM),
     A   90.,30)
       CALL SYMBOL(-0.535,4.43,0.07,1H2,90.,1)
     C PLOT BOTTOM TICK AND NUMBER
       CALL PLOT(0.,0.,3)
       CALL PLOT(-0.12,0.,2)
       CALL NUMBER(-0.4,0.,0.14,10.,0.,-1)
       FPN = ALOG10(YAXIS(ISIZE+1))
       CALL NUMBER(-0.135,0.105,0.07,FPN,0.,-1)
     C PLOT REMAINING TICKS AND NUMBERS
       II = 6. * YAXIS(ISIZE+3)                        @ NUMBER OF CYCLES
       YY = 0.
       DO 57 I = 1,II
       DO 56 J = 2,9
       X = YY + ALOG10(J)/YAXIS(ISIZE+3)
       CALL PLOT(0.,X,3)
    56 CALL PLOT(-0.06,X,2)
       YY = I/YAXIS(ISIZE+3)      @ INCH-ORDINATE OF END OF ITH CYCLE
       CALL PLOT(0.,YY,3)
       CALL PLOT(-0.12,YY,2)
       CALL NUMBER(-0.4,YY,0.14,10.,0.,-1)
       FPN = FPN + 1.
    57 CALL NUMBER(-0.135,YY+0.105,0.07,FPN,0.,-1)
       YAXIS(ISIZE+2) = YAXIS(ISIZE+3)
       CALL LGLIN(XAXIS,YAXIS,ISIZE,1,0,0,1)
       GOTO 4
     C END PLOT ROUTINE
   999 CALL PLOT(12.,-36.,-3)
       CALL PLOT(0.,0.5,-3)
       CALL PLOT(0.,35.,2)
       CALL PLOT(2.,-36.,999)
       RETURN
       END

END OF COMPILATION:        NO  DIAGNOSTICS.
```

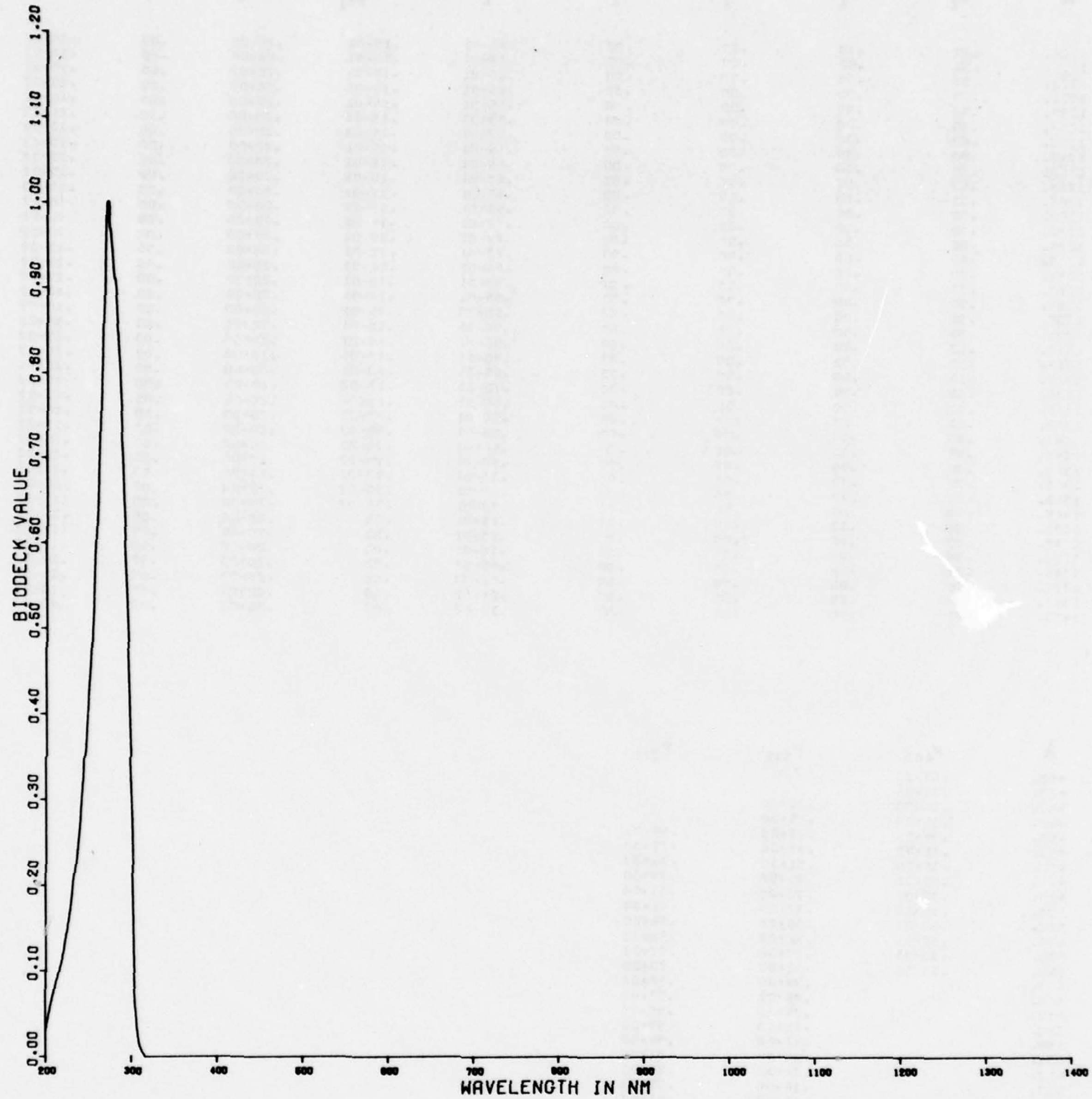
λ	S_λ	U_λ	V_λ	V'_λ	T_λ	$T \cdot Ape_\lambda$	$1/C_A$	A_λ
200.	.30-01	.00	.00	.00	.00	.00	.00	.10+01
201.	.33-01	.00	.00	.00	.00	.00	.00	.10+01
202.	.40-01	.00	.00	.00	.00	.00	.00	.10+01
203.	.44-01	.00	.00	.00	.00	.00	.00	.10+01
204.	.50-01	.00	.00	.00	.00	.00	.00	.10+01
205.	.53-01	.00	.00	.00	.00	.00	.00	.10+01
206.	.59-01	.00	.00	.00	.00	.00	.00	.10+01
207.	.63-01	.00	.00	.00	.00	.00	.00	.10+01
208.	.68-01	.00	.00	.00	.00	.00	.00	.10+01
209.	.71-01	.00	.00	.00	.00	.00	.00	.10+01
210.	.75-01	.00	.00	.00	.00	.00	.00	.10+01
211.	.81-01	.00	.00	.00	.00	.00	.00	.10+01
212.	.86-01	.00	.00	.00	.00	.00	.00	.10+01
213.	.90-01	.00	.00	.00	.00	.00	.00	.10+01
214.	.92-01	.00	.00	.00	.00	.00	.00	.10+01
215.	.97-01	.00	.00	.00	.00	.00	.00	.10+01
216.	.10+00	.00	.00	.00	.00	.00	.00	.10+01
217.	.11+00	.00	.00	.00	.00	.00	.00	.10+01
218.	.11+00	.00	.00	.00	.00	.00	.00	.10+01
219.	.11+00	.00	.00	.00	.00	.00	.00	.10+01
220.	.12+00	.00	.00	.00	.00	.00	.00	.10+01
221.	.12+00	.00	.00	.00	.00	.00	.00	.10+01
222.	.13+00	.00	.00	.00	.00	.00	.00	.10+01
223.	.14+00	.00	.00	.00	.00	.00	.00	.10+01
224.	.14+00	.00	.00	.00	.00	.00	.00	.10+01
225.	.15+00	.00	.00	.00	.00	.00	.00	.10+01
226.	.15+00	.00	.00	.00	.00	.00	.00	.10+01
227.	.16+00	.00	.00	.00	.00	.00	.00	.10+01
228.	.17+00	.00	.00	.00	.00	.00	.00	.10+01
229.	.17+00	.00	.00	.00	.00	.00	.00	.10+01
230.	.18+00	.00	.00	.00	.00	.00	.00	.10+01
231.	.19+00	.00	.00	.00	.00	.00	.00	.10+01
232.	.20+00	.00	.00	.00	.00	.00	.00	.10+01
233.	.21+00	.00	.00	.00	.00	.00	.00	.10+01
234.	.21+00	.00	.00	.00	.00	.00	.00	.10+01
235.	.22+00	.00	.00	.00	.00	.00	.00	.10+01
236.	.23+00	.00	.00	.00	.00	.00	.00	.10+01
237.	.24+00	.00	.00	.00	.00	.00	.00	.10+01
238.	.25+00	.00	.00	.00	.00	.00	.00	.10+01
239.	.26+00	.00	.00	.00	.00	.00	.00	.10+01
240.	.27+00	.56+00	.00	.00	.00	.00	.00	.10+01
241.	.29+00	.56+00	.00	.00	.00	.00	.00	.10+01
242.	.30+00	.56+00	.00	.00	.00	.00	.00	.10+01
243.	.32+00	.57+00	.00	.00	.00	.00	.00	.10+01
244.	.33+00	.57+00	.00	.00	.00	.00	.00	.10+01
245.	.35+00	.58+00	.00	.00	.00	.00	.00	.10+01
246.	.36+00	.58+00	.00	.00	.00	.00	.00	.10+01
247.	.38+00	.58+00	.00	.00	.00	.00	.00	.10+01
248.	.39+00	.58+00	.00	.00	.00	.00	.00	.10+01
249.	.41+00	.58+00	.00	.00	.00	.00	.00	.10+01
250.	.43+00	.57+00	.00	.00	.00	.00	.00	.10+01
251.	.44+00	.56+00	.00	.00	.00	.00	.00	.10+01
252.	.45+00	.56+00	.00	.00	.00	.00	.00	.10+01
253.	.47+00	.55+00	.00	.00	.00	.00	.00	.10+01
254.	.50+00	.54+00	.00	.00	.00	.00	.00	.10+01
255.	.52+00	.53+00	.00	.00	.00	.00	.00	.10+01
256.	.55+00	.52+00	.00	.00	.00	.00	.00	.10+01
257.	.58+00	.50+00	.00	.00	.00	.00	.00	.10+01
258.	.60+00	.48+00	.00	.00	.00	.00	.00	.10+01
259.	.63+00	.46+00	.00	.00	.00	.00	.00	.10+01
260.	.65+00	.42+00	.00	.00	.00	.00	.00	.10+01
261.	.68+00	.40+00	.00	.00	.00	.00	.00	.10+01
262.	.71+00	.36+00	.00	.00	.00	.00	.00	.10+01
263.	.75+00	.32+00	.00	.00	.00	.00	.00	.10+01
264.	.79+00	.29+00	.00	.00	.00	.00	.00	.10+01
265.	.81+00	.26+00	.00	.00	.00	.00	.00	.10+01
266.	.86+00	.23+00	.00	.00	.00	.00	.00	.10+01
267.	.88+00	.21+00	.00	.00	.00	.00	.00	.10+01
268.	.94+00	.18+00	.00	.00	.00	.00	.00	.10+01
269.	.97+00	.16+00	.00	.00	.00	.00	.00	.10+01
270.	.10+01	.14+00	.00	.00	.00	.00	.00	.10+01
271.	.10+01	.13+00	.00	.00	.00	.00	.00	.10+01
272.	.10+01	.11+00	.00	.00	.00	.00	.00	.10+01
273.	.97+00	.10+00	.00	.00	.00	.00	.00	.10+01
274.	.97+00	.90-01	.00	.00	.00	.00	.00	.10+01
275.	.95+00	.74-01	.00	.00	.00	.00	.00	.10+01
276.	.94+00	.68-01	.00	.00	.00	.00	.00	.10+01
277.	.92+00	.64-01	.00	.00	.00	.00	.00	.10+01
278.	.91+00	.62-01	.00	.00	.00	.00	.00	.10+01
279.	.91+00	.61-01	.00	.00	.00	.00	.00	.10+01
280.	.90+00	.60-01	.00	.00	.00	.00	.00	.10+01
281.	.88+00	.61-01	.00	.00	.00	.00	.00	.10+01
282.	.86+00	.62-01	.00	.00	.00	.00	.00	.10+01
283.	.84+00	.66-01	.00	.00	.00	.00	.00	.10+01
284.	.82+00	.76-01	.00	.00	.00	.00	.00	.10+01
285.	.81+00	.90-01	.00	.00	.00	.00	.00	.10+01
286.	.78+00	.11+00	.00	.00	.00	.00	.00	.10+01
287.	.75+00	.13+00	.00	.00	.00	.00	.00	.10+01
288.	.71+00	.17+00	.00	.00	.00	.00	.00	.10+01
289.	.70+00	.22+00	.00	.00	.00	.00	.00	.10+01
290.	.65+00	.31+00	.00	.00	.00	.00	.00	.10+01
291.	.63+00	.46+00	.00	.00	.00	.00	.00	.10+01
292.	.59+00	.64+00	.00	.00	.00	.00	.00	.10+01
293.	.57+00	.80+00	.00	.00	.00	.00	.00	.10+01
294.	.54+00	.92+00	.00	.00	.00	.00	.00	.10+01
295.	.50+00	.98+00	.00	.00	.00	.00	.00	.10+01
296.	.47+00	.99+00	.00	.00	.00	.00	.00	.10+01
297.	.43+00	.10+01	.00	.00	.00	.00	.00	.10+01
298.	.38+00	.98+00	.00	.00	.00	.00	.00	.10+01
299.	.33+00	.90+00	.00	.00	.00	.00	.00	.10+01

λ	S_λ	U_λ	V_λ	V'_λ	T_λ	$T\cdot A_{pe_\lambda}$	$1/C_\lambda$	A_λ	B_λ	$\bar{X}_\lambda$	$\bar{Y}_\lambda$	$\bar{Z}_\lambda$
300.	.30+00	.83+00	.00	.00	.00	.00	.00	.10+01				
301.	.27+00	.72+00	.00	.00	.00	.00	.00	.10+01				
302.	.20+00	.60+00	.00	.00	.00	.00	.00	.10+01				
303.	.11+00	.52+00	.00	.00	.00	.00	.00	.75+00				
304.	.76-01	.44+00	.00	.00	.00	.00	.00	.50+00				
305.	.60-01	.33+00	.00	.00	.00	.00	.00	.30+00				
306.	.50-01	.30+00	.00	.00	.00	.00	.00	.19+00				
307.	.33-01	.25+00	.00	.00	.00	.00	.00	.12+00				
308.	.25-01	.20+00	.00	.00	.00	.00	.00	.75-01				
309.	.19-01	.15+00	.00	.00	.00	.00	.00	.48-01				
310.	.13-01	.11+00	.00	.00	.00	.00	.00	.30-01				
311.	.10-01	.82-01	.00	.00	.00	.00	.00	.19-01				
312.	.75-02	.58-01	.00	.00	.00	.00	.00	.12-01				
313.	.60-02	.50-01	.00	.00	.00	.00	.00	.80-02				
314.	.43-02	.29-01	.00	.00	.00	.00	.00	.50-02				
315.	.30-02	.10-01	.00	.00	.00	.00	.00	.30-02				
316.	.00	.91-02	.00	.00	.00	.00	.00	.00				
317.	.00	.80-02	.00	.00	.00	.00	.00	.00				
318.	.00	.68-02	.00	.00	.00	.00	.00	.00				
319.	.00	.56-02	.00	.00	.00	.00	.00	.00				
320.	.00	.50-02	.00	.00	.00	.00	.00	.00				
321.	.00	.42-02	.00	.00	.00	.00	.00	.00				
322.	.00	.36-02	.00	.00	.00	.00	.00	.00				
325.	.00	.30-02	.00	.00	.00	.00	.00	.00				
330.	.00	.00	.00	.00	.00	.00	.00	.00				
335.	.00	.00	.00	.00	.00	.00	.00	.00				
340.	.00	.00	.00	.00	.00	.00	.00	.00				
345.	.00	.00	.00	.00	.00	.00	.00	.00				
350.	.00	.00	.00	.00	.00	.00	.00	.00				
355.	.00	.00	.00	.00	.00	.00	.00	.00				
360.	.00	.00	.00	.00	.00	.00	.00	.00				
365.	.00	.00	.00	.00	.00	.00	.00	.00				
370.	.00	.00	.00	.00	.00	.00	.00	.00				
375.	.00	.00	.00	.00	.00	.00	.00	.00				
380.	.00	.00	.40-04	.59-03	.00	.00	.00	.00		.14-02		.65-02
385.	.00	.00	.68-04	.10-02	.00	.00	.00	.00		.22-02	.10-03	.10-01
390.	.00	.00	.12-03	.22-02	.10-01	.00	.00	.00		.42-02	.10-03	.20-01
395.	.00	.00	.19-03	.40-02	.50-01	.00	.00	.00		.76-02	.20-03	.36-01
400.	.00	.00	.40-03	.93-02	.80-01	.00	.10+01	.00	.10+00	.14-01	.40-03	.68-01
405.	.00	.00	.58-03	.18-01	.11+00	.10-01	.20+01	.00	.20+00	.23-01	.60-03	.11+00
410.	.00	.00	.17-02	.35-01	.22+00	.50-01	.40+01	.00	.40+00	.44-01	.12-02	.21+00
415.	.00	.00	.20-02	.60-01	.28+00	.84-01	.80+01	.00	.80+00	.78-01	.22-02	.37+00
420.	.00	.00	.40-02	.97-01	.33+00	.20+00	.90+01	.00	.90+00	.13+00	.40-02	.65+00
425.	.00	.00	.65-02	.15+00	.38+00	.25+00	.95+01	.00	.95+00	.21+00	.73-02	.10+01
430.	.00	.00	.12-01	.20+00	.42+00	.30+00	.98+01	.00	.98+00	.28+00	.12-01	.14+01
435.	.00	.00	.17-01	.27+00	.46+00	.37+00	.10+02	.00	.10+01	.33+00	.17-01	.16+01
440.	.00	.00	.23-01	.33+00	.50+00	.45+00	.10+02	.00	.10+01	.35+00	.23-01	.17+01
445.	.00	.00	.30-01	.40+00	.57+00	.52+00	.97+01	.00	.97+00	.35+00	.30-01	.18+01
450.	.00	.00	.38-01	.45+00	.63+00	.58+00	.94+01	.00	.94+00	.34+00	.38-01	.18+01
455.	.00	.00	.50-01	.50+00	.65+00	.60+00	.90+01	.00	.90+00	.32+00	.48-01	.17+01
460.	.00	.00	.60-01	.57+00	.68+00	.62+00	.80+01	.00	.80+00	.29+00	.60-01	.17+01
465.	.00	.00	.72-01	.64+00	.69+00	.64+00	.70+01	.00	.70+00	.25+00	.74-01	.15+01
470.	.00	.00	.91-01	.68+00	.71+00	.65+00	.62+01	.00	.62+00	.20+00	.91-01	.13+01
475.	.00	.00	.11+00	.73+00	.72+00	.66+00	.55+01	.00	.55+00	.14+00	.11+00	.10+01
480.	.00	.00	.14+00	.79+00	.74+00	.67+00	.45+01	.00	.45+00	.96-01	.14+00	.81+00
485.	.00	.00	.16+00	.85+00	.76+00	.68+00	.40+01	.00	.40+00	.58-01	.17+00	.62+00
490.	.00	.00	.21+00	.90+00	.77+00	.69+00	.22+01	.00	.22+00	.32-01	.21+00	.46+00
495.	.00	.00	.25+00	.95+00	.79+00	.70+00	.16+01	.00	.16+00	.15-01	.26+00	.35+00
500.	.00	.00	.32+00	.98+00	.81+00	.71+00	.10+01	.00	.10+00	.49-02	.32+00	.27+00
505.	.00	.00	.40+00	.10+01	.82+00	.72+00	.10+01	.00	.79-01	.24-02	.41+00	.21+00
510.	.00	.00	.50+00	.10+01	.84+00	.72+00	.10+01	.00	.63-01	.93-02	.50+00	.16+00
515.	.00	.00	.62+00	.98+00	.86+00	.72+00	.10+01	.00	.50-01	.29-01	.61+00	.11+00
520.	.00	.00	.71+00	.94+00	.87+00	.73+00	.10+01	.00	.40-01	.63-01	.71+00	.78-01
525.	.00	.00	.80+00	.90+00	.88+00	.73+00	.10+01	.00	.32-01	.11+00	.79+00	.57-01
530.	.00	.00	.86+00	.81+00	.89+00	.73+00	.10+01	.00	.25-01	.17+00	.86+00	.42-01
535.	.00	.00	.92+00	.75+00	.89+00	.74+00	.10+01	.00	.20-01	.23+00	.91+00	.30-01
540.	.00	.00	.95+00	.65+00	.90+00	.74+00	.10+01	.00	.16-01	.29+00	.95+00	.20-01
545.	.00	.00	.98+00	.55+00	.91+00	.74+00	.10+01	.00	.13-01	.36+00	.98+00	.13-01
550.	.00	.00	.99+00	.48+00	.92+00	.75+00	.10+01	.00	.10-01	.43+00	.99+00	.87-02
555.	.00	.00	.10+01	.39+00	.92+00	.75+00	.10+01	.00	.79-02	.51+00	.10+01	.57-02
560.	.00	.00	.99+00	.32+00	.93+00	.75+00	.10+01	.00	.63-02	.59+00	.99+00	.39-02
565.	.00	.00	.97+00	.27+00	.93+00	.76+00	.10+01	.00	.50-02	.68+00	.98+00	.27-02
570.	.00	.00	.95+00	.21+00	.94+00	.76+00	.10+01	.00	.40-02	.76+00	.95+00	.21-02
575.	.00	.00	.91+00	.17+00	.94+00	.75+00	.10+01	.00	.32-02	.84+00	.91+00	.18-02
580.	.00	.00	.87+00	.12+00	.95+00	.75+00	.10+01	.00	.25-02	.92+00	.87+00	.17-02
585.	.00	.00	.81+00	.10+00	.95+00	.74+00	.10+01	.00	.20-02	.98+00	.82+00	.14-02
590.	.00	.00	.76+00	.65-01	.95+00	.74+00	.10+01	.00	.16-02	.10+01	.76+00	.11-02
595.	.00	.00	.71+00	.53-01	.96+00	.73+00	.10+01	.00	.13-02	.11+01	.70+00	.10-02
600.	.00	.00	.63+00	.33-01	.96+00	.73+00	.10+01	.00	.10-02	.11+01	.63+00	.80-03
605.	.00	.00	.58+00	.23-01	.96+00	.72+00	.10+01	.00	.10-02	.10+01	.57+00	.60-03
610.	.00	.00	.50+00	.16-01	.96+00	.72+00	.10+01	.00	.10-02	.10+01	.50+00	.30-03
615.	.00	.00	.45+00	.11-01	.96+00	.71+00	.10+01	.00	.10-02	.94+00	.44+00	.20-03
620.	.00	.00	.38+00	.74-02	.96+00	.70+00	.10+01	.00	.10-02	.85+00	.38+00	.20-03
625.	.00	.00	.32+00	.43-02	.96+00	.69+00	.10+01	.00	.10-02	.75+00	.32+00	.10-03
630.	.00	.00	.27+00	.33-02	.96+00	.68+00	.10+01	.00	.10-02	.64+00	.27+00	
635.	.00	.00	.21+00	.21-02	.96+00	.67+00	.10+01	.00	.10-02	.54+00	.22+00	
640.	.00	.00	.18+00	.15-02	.96+00	.66+00	.10+01	.00	.10-02	.45+00	.18+00	
645.	.00	.00	.13+00	.90-03	.96+00	.65+00	.10+01	.00	.10-02	.36+00	.14+00	
650.	.00	.00	.11+00	.68-03	.96+00	.65+00	.10+01	.00	.10-02	.28+00	.11+00	
655.	.00	.00	.75-01	.45-03	.96+00	.63+00	.10+01	.00	.10-02	.22+00	.82-01	
660.	.00	.00	.61-01	.31-03	.96+00	.62+00	.10+01	.00	.10-02	.16+00	.61-01	
665.	.00	.00	.44-01	.22-03	.96+00	.61+00	.10+01	.00	.10-02	.12+00	.45-01	
670.	.00	.00	.32-01	.15-03	.96+00	.60+00	.10+01	.00	.10-02	.97-01	.32-01	
675.	.00	.00	.22-01	.11-03	.96+00	.59+00	.10+01	.00	.10-02	.64-01	.23-01	
680.	.00	.00	.17-01	.71-04	.96+00	.59+00	.10+01	.00	.10-02	.47-01	.17-01	
685.	.00	.00	.11-01	.53-04	.96+00	.58+00	.10+01	.00	.10-02	.33-01	.12-01	
690.	.00	.00	.82-02	.35-04	.96+00	.57+00	.10+01	.00	.10-02	.23-01	.82-02	
695.	.00	.00	.59-02	.25-04	.96+00	.56+00	.10+01	.00	.10-02	.16-01	.57-02	
700.	.00	.00	.41-02	.19-04	.96+00	.55+00	.10+01	.00	.10-02	.11-01	.41-02	
705.	.00	.00	.30-02	.13-04	.96+00	.54+00	.98+00	.00	.10-02	.81-02	.29-02	

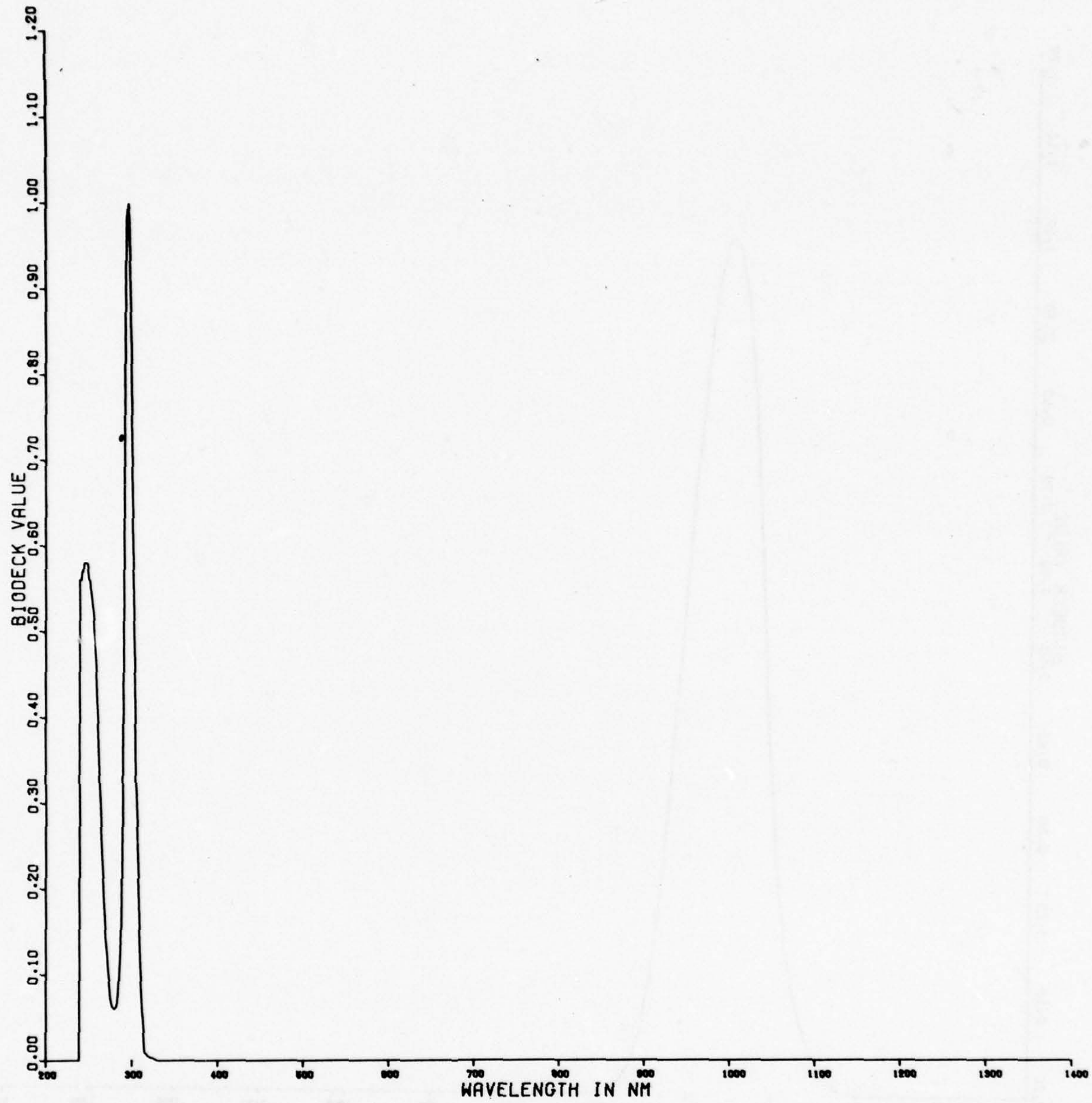
λ	S_λ	U_λ	V_λ	V'_λ	T_λ	$T \cdot A_{pe_\lambda}$	$1/C_A$	A_λ	B_λ	$\bar{X}_\lambda$	$\bar{Y}_\lambda$
710.	.00	.00	.21-02	.91-05	.96+00	.54+00	.95+00	.00	.10-02	.58-02	.21-02
715.	.00	.00	.14-02	.70-05	.96+00	.53+00	.93+00	.00	.10-02	.41-02	.15-02
720.	.00	.00	.11-02	.48-05	.96+00	.52+00	.91+00	.00	.10-02	.29-02	.10-02
725.	.00	.00	.77-03	.37-05	.96+00	.51+00	.89+00	.00	.10-02	.20-02	.70-03
730.	.00	.00	.52-03	.26-05	.96+00	.50+00	.87+00	.00	.10-02	.14-02	.50-03
735.	.00	.00	.35-03	.20-05	.96+00	.50+00	.85+00	.00	.10-02	.10-02	.40-03
740.	.00	.00	.25-03	.14-05	.96+00	.49+00	.83+00	.00	.10-02	.70-03	.30-03
745.	.00	.00	.17-03	.11-05	.96+00	.48+00	.81+00	.00	.10-02	.50-03	.20-03
750.	.00	.00	.12-03	.76-06	.96+00	.47+00	.79+00	.00	.10-02	.30-03	.10-03
755.	.00	.00	.85-04	.55-06	.96+00	.46+00	.78+00	.00	.10-02	.20-03	.10-03
760.	.00	.00	.60-04	.42-06	.96+00	.45+00	.76+00	.00	.10-02	.20-03	.10-03
765.	.00	.00	.42-04	.31-06	.96+00	.44+00	.74+00	.00	.10-02	.10-03	
770.	.00	.00	.30-04	.24-05	.96+00	.43+00	.73+00	.00	.10-02	.10-03	
775.	.00	.00	.20-04	.18-06	.96+00	.43+00	.71+00	.00	.10-02		
780.	.00	.00	.15-04	.14-06	.96+00	.42+00	.70+00	.00	.10-02		
785.	.00	.00	.00	.00	.96+00	.40+00	.68+00	.00	.10-02		
790.	.00	.00	.00	.00	.96+00	.39+00	.67+00	.00	.10-02		
795.	.00	.00	.00	.00	.96+00	.38+00	.65+00	.00	.10-02		
800.	.00	.00	.00	.00	.96+00	.37+00	.63+00	.00	.10-02		
805.	.00	.00	.00	.00	.96+00	.36+00	.63+00	.00	.10-02		
810.	.00	.00	.00	.00	.96+00	.35+00	.61+00	.00	.10-02		
815.	.00	.00	.00	.00	.96+00	.33+00	.60+00	.00	.10-02		
820.	.00	.00	.00	.00	.96+00	.32+00	.59+00	.00	.10-02		
825.	.00	.00	.00	.00	.96+00	.31+00	.57+00	.00	.10-02		
830.	.00	.00	.00	.00	.96+00	.31+00	.55+00	.00	.10-02		
835.	.00	.00	.00	.00	.96+00	.30+00	.55+00	.00	.10-02		
840.	.00	.00	.00	.00	.96+00	.30+00	.53+00	.00	.10-02		
845.	.00	.00	.00	.00	.96+00	.29+00	.52+00	.00	.10-02		
850.	.00	.00	.00	.00	.96+00	.29+00	.51+00	.00	.10-02		
855.	.00	.00	.00	.00	.96+00	.28+00	.50+00	.00	.10-02		
860.	.00	.00	.00	.00	.96+00	.28+00	.49+00	.00	.10-02		
865.	.00	.00	.00	.00	.96+00	.27+00	.48+00	.00	.10-02		
870.	.00	.00	.00	.00	.96+00	.27+00	.47+00	.00	.10-02		
875.	.00	.00	.00	.00	.96+00	.26+00	.46+00	.00	.10-02		
880.	.00	.00	.00	.00	.96+00	.26+00	.45+00	.00	.10-02		
885.	.00	.00	.00	.00	.96+00	.25+00	.44+00	.00	.10-02		
890.	.00	.00	.00	.00	.96+00	.25+00	.43+00	.00	.10-02		
895.	.00	.00	.00	.00	.95+00	.24+00	.42+00	.00	.10-02		
900.	.00	.00	.00	.00	.95+00	.24+00	.41+00	.00	.10-02		
905.	.00	.00	.00	.00	.94+00	.23+00	.40+00	.00	.10-02		
910.	.00	.00	.00	.00	.94+00	.23+00	.39+00	.00	.10-02		
915.	.00	.00	.00	.00	.93+00	.22+00	.38+00	.00	.10-02		
920.	.00	.00	.00	.00	.93+00	.22+00	.37+00	.00	.10-02		
925.	.00	.00	.00	.00	.92+00	.21+00	.37+00	.00	.10-02		
930.	.00	.00	.00	.00	.92+00	.21+00	.36+00	.00	.10-02		
935.	.00	.00	.00	.00	.91+00	.20+00	.35+00	.00	.10-02		
940.	.00	.00	.00	.00	.90+00	.19+00	.34+00	.00	.10-02		
945.	.00	.00	.00	.00	.88+00	.18+00	.33+00	.00	.10-02		
950.	.00	.00	.00	.00	.83+00	.17+00	.32+00	.00	.10-02		
955.	.00	.00	.00	.00	.78+00	.13+00	.32+00	.00	.10-02		
960.	.00	.00	.00	.00	.70+00	.11+00	.31+00	.00	.10-02		
965.	.00	.00	.00	.00	.62+00	.85-01	.31+00	.00	.10-02		
970.	.00	.00	.00	.00	.54+00	.75-01	.30+00	.00	.10-02		
975.	.00	.00	.00	.00	.52+00	.77-01	.29+00	.00	.10-02		
980.	.00	.00	.00	.00	.50+00	.78-01	.29+00	.00	.10-02		
985.	.00	.00	.00	.00	.48+00	.82-01	.28+00	.00	.10-02		
990.	.00	.00	.00	.00	.45+00	.85-01	.27+00	.00	.10-02		
995.	.00	.00	.00	.00	.43+00	.90-01	.27+00	.00	.10-02		
1000.	.00	.00	.00	.00	.42+00	.92-01	.26+00	.00	.10-02		
1005.	.00	.00	.00	.00	.41+00	.93-01	.26+00	.00	.10-02		
1010.	.00	.00	.00	.00	.41+00	.95-01	.25+00	.00	.10-02		
1015.	.00	.00	.00	.00	.42+00	.95-01	.24+00	.00	.10-02		
1020.	.00	.00	.00	.00	.42+00	.95-01	.24+00	.00	.10-02		
1025.	.00	.00	.00	.00	.43+00	.97-01	.23+00	.00	.10-02		
1030.	.00	.00	.00	.00	.45+00	.10+00	.23+00	.00	.10-02		
1035.	.00	.00	.00	.00	.46+00	.10+00	.22+00	.00	.10-02		
1040.	.00	.00	.00	.00	.48+00	.10+00	.22+00	.00	.10-02		
1045.	.00	.00	.00	.00	.52+00	.10+00	.22+00	.00	.10-02		
1050.	.00	.00	.00	.00	.56+00	.11+00	.21+00	.00	.10-02		
1055.	.00	.00	.00	.00	.60+00	.11+00	.20+00	.00	.10-02		
1060.	.00	.00	.00	.00	.64+00	.12+00	.20+00	.00	.10-02		
1065.	.00	.00	.00	.00	.67+00	.12+00	.20+00	.00	.10-02		
1070.	.00	.00	.00	.00	.69+00	.13+00	.20+00	.00	.10-02		
1075.	.00	.00	.00	.00	.71+00	.13+00	.20+00	.00	.10-02		
1080.	.00	.00	.00	.00	.73+00	.13+00	.20+00	.00	.10-02		
1085.	.00	.00	.00	.00	.75+00	.13+00	.20+00	.00	.10-02		
1090.	.00	.00	.00	.00	.76+00	.14+00	.20+00	.00	.10-02		
1095.	.00	.00	.00	.00	.77+00	.14+00	.20+00	.00	.10-02		
1100.	.00	.00	.00	.00	.78+00	.14+00	.20+00	.00	.10-02		
1105.	.00	.00	.00	.00	.78+00	.14+00	.20+00	.00	.10-02		
1110.	.00	.00	.00	.00	.79+00	.14+00	.20+00	.00	.10-02		
1115.	.00	.00	.00	.00	.79+00	.14+00	.20+00	.00	.10-02		
1120.	.00	.00	.00	.00	.79+00	.13+00	.20+00	.00	.10-02		
1125.	.00	.00	.00	.00	.78+00	.13+00	.20+00	.00	.10-02		
1130.	.00	.00	.00	.00	.77+00	.13+00	.20+00	.00	.10-02		
1135.	.00	.00	.00	.00	.76+00	.12+00	.20+00	.00	.10-02		
1140.	.00	.00	.00	.00	.75+00	.12+00	.20+00	.00	.10-02		
1145.	.00	.00	.00	.00	.72+00	.11+00	.20+00	.00	.10-02		
1150.	.00	.00	.00	.00	.69+00	.10+00	.20+00	.00	.10-02		
1155.	.00	.00	.00	.00	.60+00	.62-01	.20+00	.00	.10-02		
1160.	.00	.00	.00	.00	.50+00	.50-01	.20+00	.00	.10-02		
1165.	.00	.00	.00	.00	.39+00	.25-01	.20+00	.00	.10-02		
1170.	.00	.00	.00	.00	.28+00	.15-01	.20+00	.00	.10-02		
1175.	.00	.00	.00	.00	.23+00	.11-01	.20+00	.00	.10-02		
1180.	.00	.00	.00	.00	.18+00	.10-01	.20+00	.00	.10-02		
1185.	.00	.00	.00	.00	.15+00	.12-01	.20+00	.00	.10-02		
1190.	.00	.00	.00	.00	.12+00	.13-01	.20+00	.00	.10-02		
1195.	.00	.00	.00	.00	.11+00	.14-01	.20+00	.00	.10-02		
1200.	.00	.00	.00	.00	.10+00	.15-01	.20+00	.00	.10-02		
1205.	.00	.00	.00	.00	.90-01	.15-01	.20+00	.00	.10-02		

λ	S_λ	U_λ	V_λ	V'_λ	T_λ	$T \cdot A_{pe_\lambda}$	$1/C_A$	A_λ	B_λ
1210.	.00	.00	.00	.00	.80-01	.15-01	.20+00	.00	.10-02
1215.	.00	.00	.00	.00	.73-01	.15-01	.20+00	.00	.10-02
1220.	.00	.00	.00	.00	.65-01	.15-01	.20+00	.00	.10-02
1225.	.00	.00	.00	.00	.60-01	.15-01	.20+00	.00	.10-02
1230.	.00	.00	.00	.00	.55-01	.15-01	.20+00	.00	.10-02
1235.	.00	.00	.00	.00	.53-01	.15-01	.20+00	.00	.10-02
1240.	.00	.00	.00	.00	.52-01	.15-01	.20+00	.00	.10-02
1245.	.00	.00	.00	.00	.56-01	.15-01	.20+00	.00	.10-02
1250.	.00	.00	.00	.00	.60-01	.15-01	.20+00	.00	.10-02
1255.	.00	.00	.00	.00	.63-01	.16-01	.20+00	.00	.10-02
1260.	.00	.00	.00	.00	.65-01	.17-01	.20+00	.00	.10-02
1265.	.00	.00	.00	.00	.68-01	.17-01	.20+00	.00	.10-02
1270.	.00	.00	.00	.00	.72-01	.18-01	.20+00	.00	.10-02
1275.	.00	.00	.00	.00	.77-01	.18-01	.20+00	.00	.10-02
1280.	.00	.00	.00	.00	.82-01	.18-01	.20+00	.00	.10-02
1285.	.00	.00	.00	.00	.86-01	.18-01	.20+00	.00	.10-02
1290.	.00	.00	.00	.00	.90-01	.19-01	.20+00	.00	.10-02
1295.	.00	.00	.00	.00	.95-01	.20-01	.20+00	.00	.10-02
1300.	.00	.00	.00	.00	.10+00	.20-01	.20+00	.00	.10-02
1305.	.00	.00	.00	.00	.98-01	.18-01	.20+00	.00	.10-02
1310.	.00	.00	.00	.00	.95-01	.16-01	.20+00	.00	.10-02
1315.	.00	.00	.00	.00	.90-01	.12-01	.20+00	.00	.10-02
1320.	.00	.00	.00	.00	.85-01	.10-01	.20+00	.00	.10-02
1325.	.00	.00	.00	.00	.70-01	.85-02	.20+00	.00	.10-02
1330.	.00	.00	.00	.00	.65-01	.80-02	.20+00	.00	.10-02
1335.	.00	.00	.00	.00	.59-01	.50-02	.20+00	.00	.10-02
1340.	.00	.00	.00	.00	.52-01	.40-02	.20+00	.00	.10-02
1345.	.00	.00	.00	.00	.46-01	.25-02	.20+00	.00	.10-02
1350.	.00	.00	.00	.00	.40-01	.20-02	.20+00	.00	.10-02
1355.	.00	.00	.00	.00	.33-01	.12-02	.20+00	.00	.10-02
1360.	.00	.00	.00	.00	.25-01	.10-02	.20+00	.00	.10-02
1365.	.00	.00	.00	.00	.20-01	.70-03	.20+00	.00	.10-02
1370.	.00	.00	.00	.00	.15-01	.00	.20+00	.00	.10-02
1375.	.00	.00	.00	.00	.13-01	.00	.20+00	.00	.10-02
1380.	.00	.00	.00	.00	.10-01	.00	.20+00	.00	.10-02
1385.	.00	.00	.00	.00	.80-02	.00	.20+00	.00	.10-02
1390.	.00	.00	.00	.00	.50-02	.00	.20+00	.00	.10-02
1395.	.00	.00	.00	.00	.25-02	.00	.20+00	.00	.10-02
1400.	.00	.00	.00	.00	.10-02	.00	.20+00	.00	.10-02

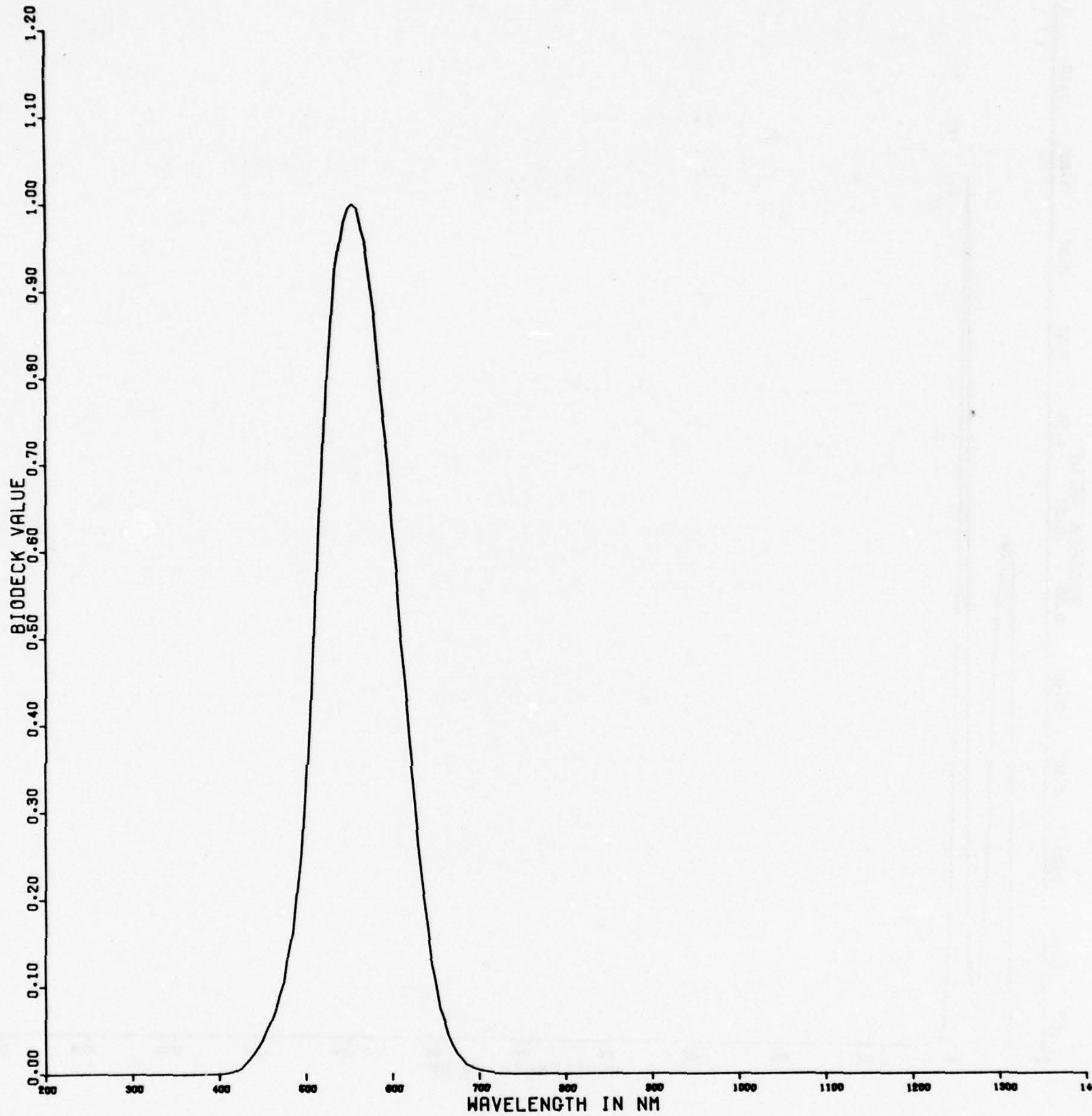
λ	P_{445}	P_{535}	P_{575}
410.	.67+00		
420.	.91+00		
430.	.92+00	.22+00	
440.	.99+00	.28+00	
450.	.98+00	.33+00	.80-01
460.	.98+00	.42+00	.13+00
470.	.73+00	.51+00	.20+00
480.	.53+00	.61+00	.26+00
490.	.33+00	.72+00	.35+00
500.	.18+00	.82+00	.45+00
510.	.90-01	.90+00	.54+00
520.	.50-01	.96+00	.62+00
530.	.30-01	.99+00	.72+00
540.	.10-01	.99+00	.80+00
550.		.94+00	.86+00
560.		.86+00	.93+00
570.		.74+00	.99+00
580.		.61+00	.99+00
590.		.47+00	.94+00
600.		.36+00	.81+00
610.		.24+00	.70+00
620.		.16+00	.55+00
630.		.10+00	.42+00
640.		.70-01	.29+00
650.		.40-01	.17+00
660.		.30-01	.80-01
670.		.20-01	.20-01
680.		.10-01	.50-02


BIODECK VALUE
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
WAVELENGTH IN NM
200
300
400
1000
1100
1200
1300
1400

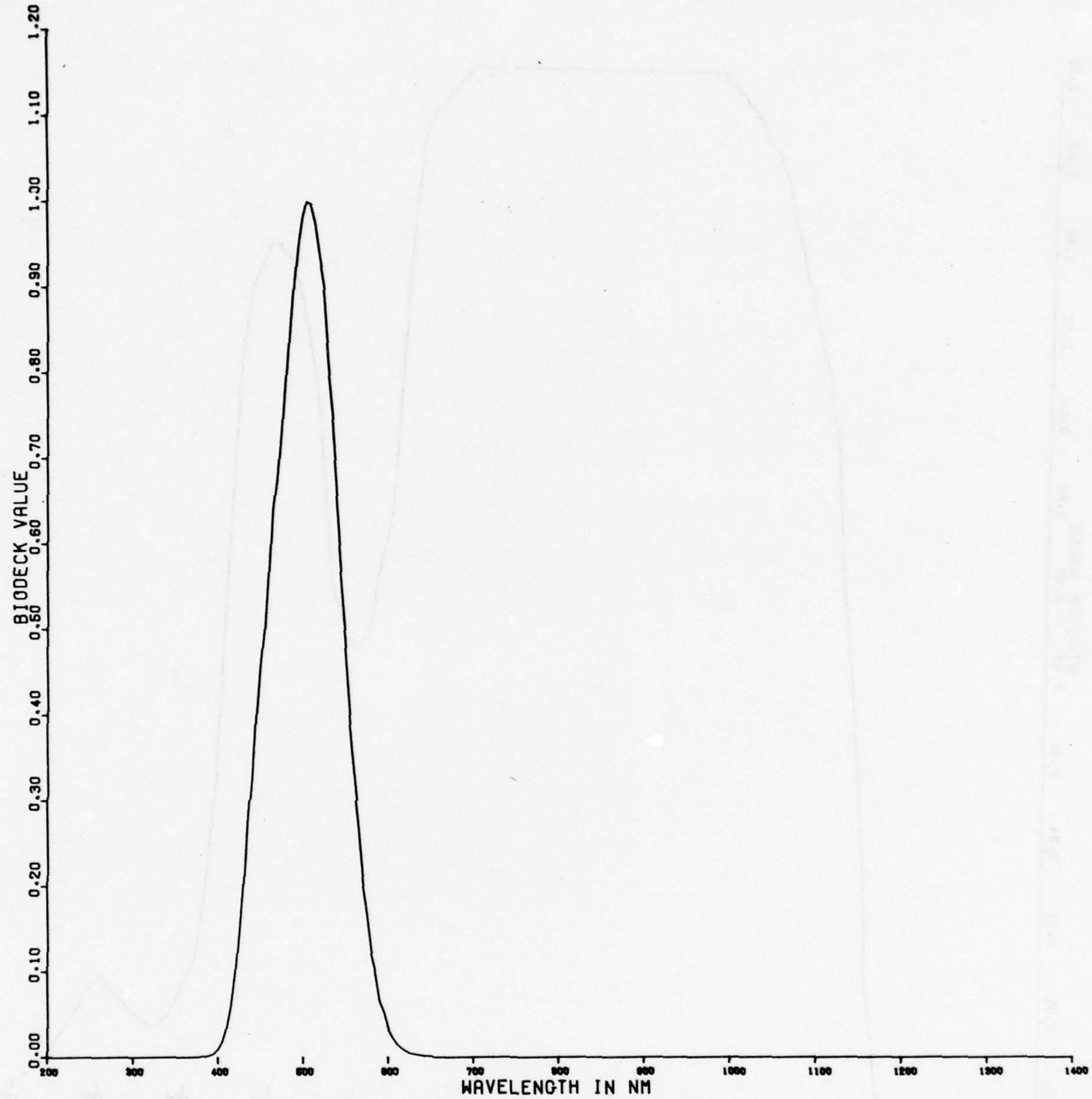
S-LAMBDA


BIODECK VALUE
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
WAVELENGTH IN NM

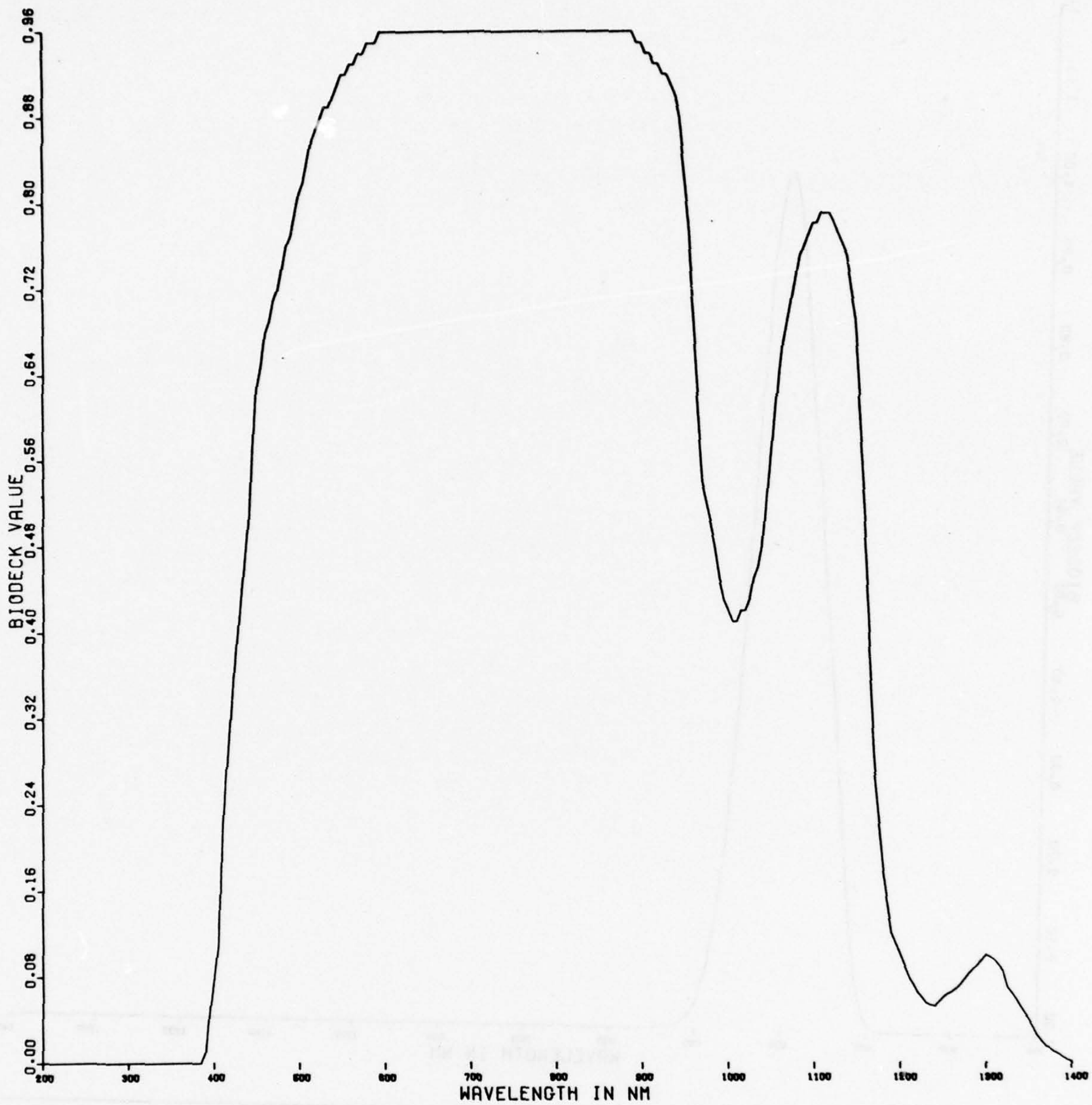
U-LAMBDA B-37


BIODECK VALUE
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
WAVELENGTH IN NM

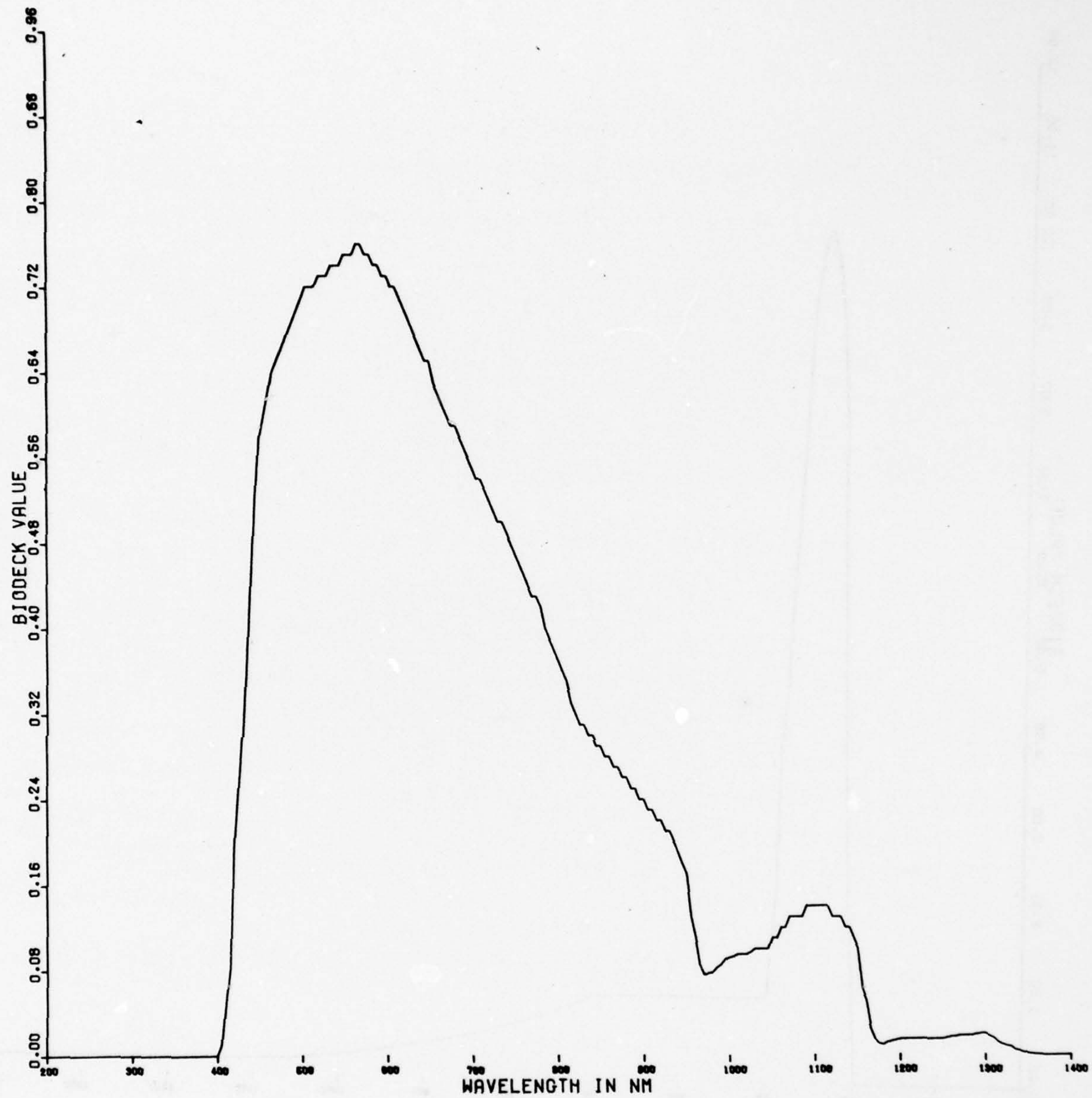
V-LAMBDA



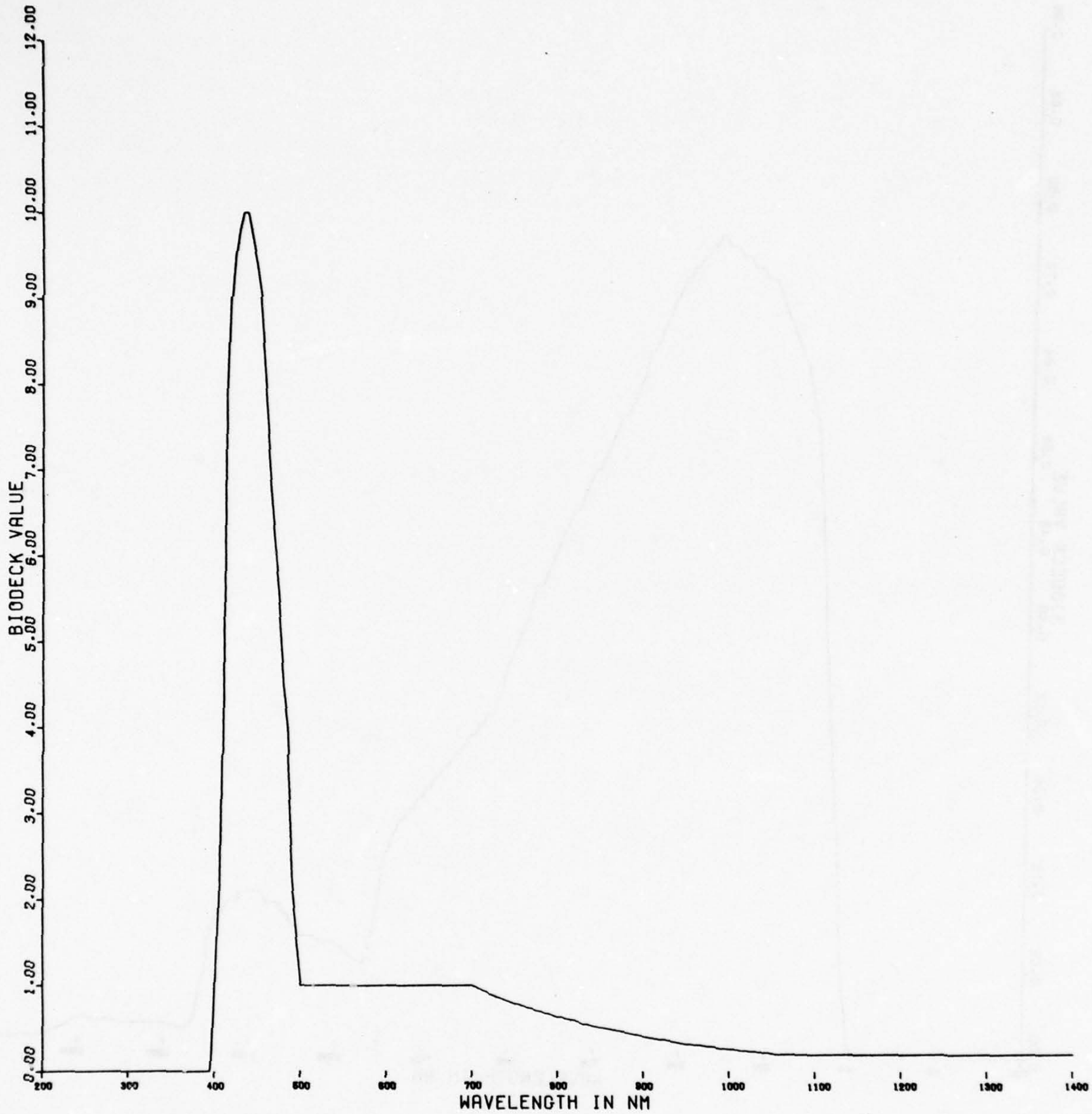
V*-LAMBDA B-39


BIODECK VALUE
0.00
0.08
0.16
0.24
0.32
0.40
0.48
0.56
0.64
0.72
0.80
0.88
0.96
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
WAVELENGTH IN NM

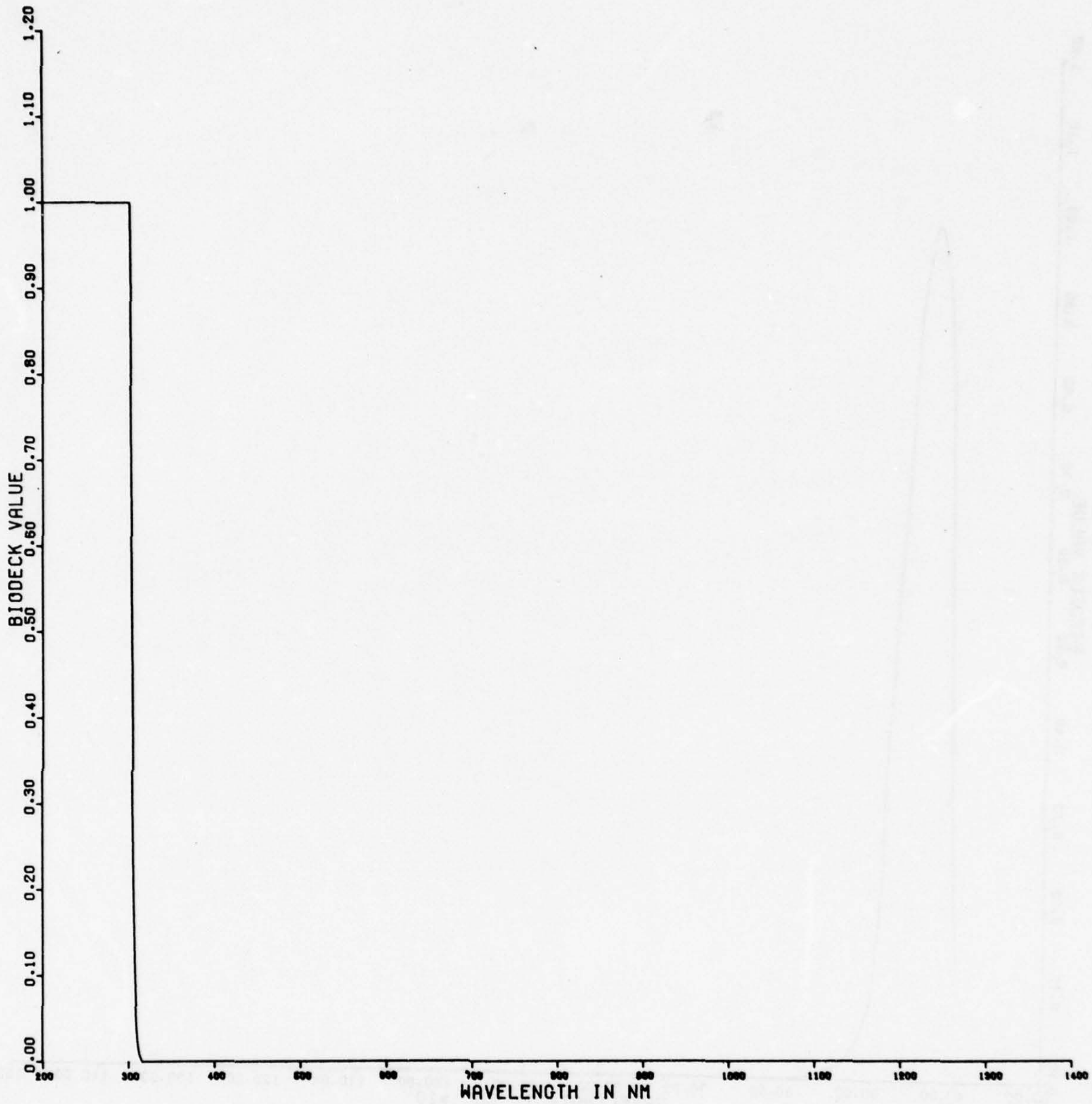
T-LAMBDA B-40



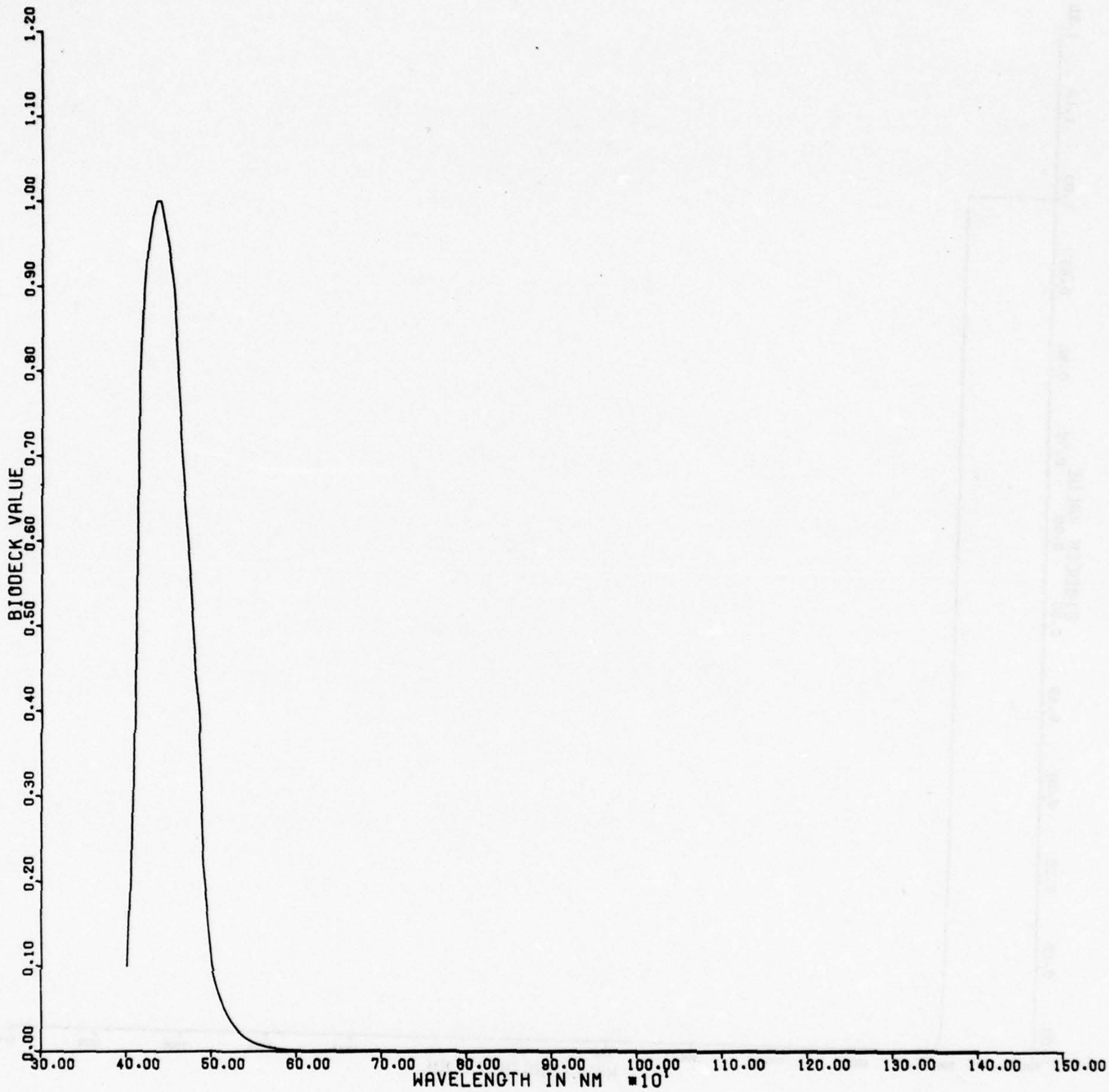
T-A-LAMBDA B-41


BIODECK VALUE
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
WAVELENGTH IN NM

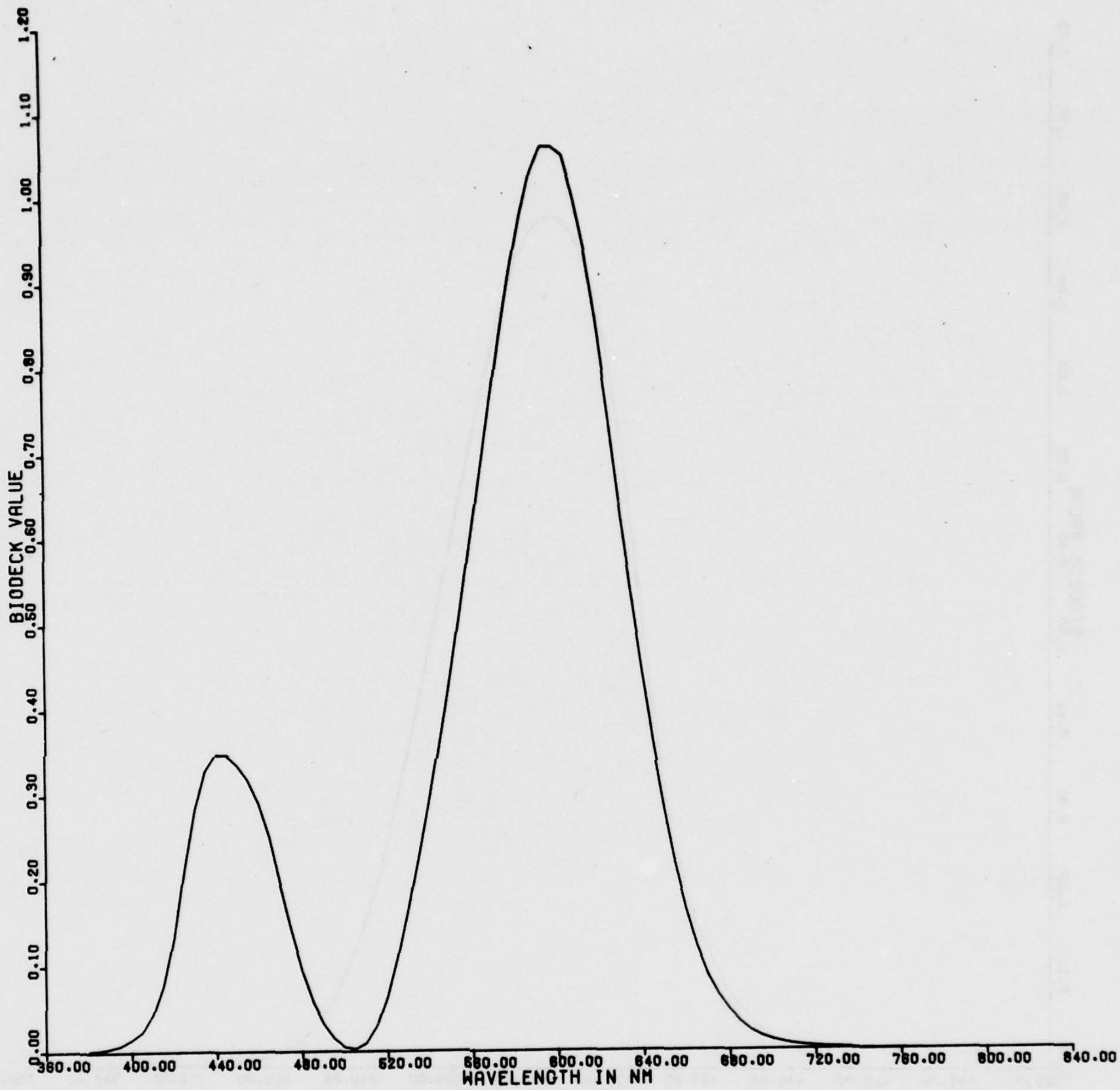
C-A-LAMBDA


BIODECK VALUE
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
WAVELENGTH IN NM

A-LAMBDA

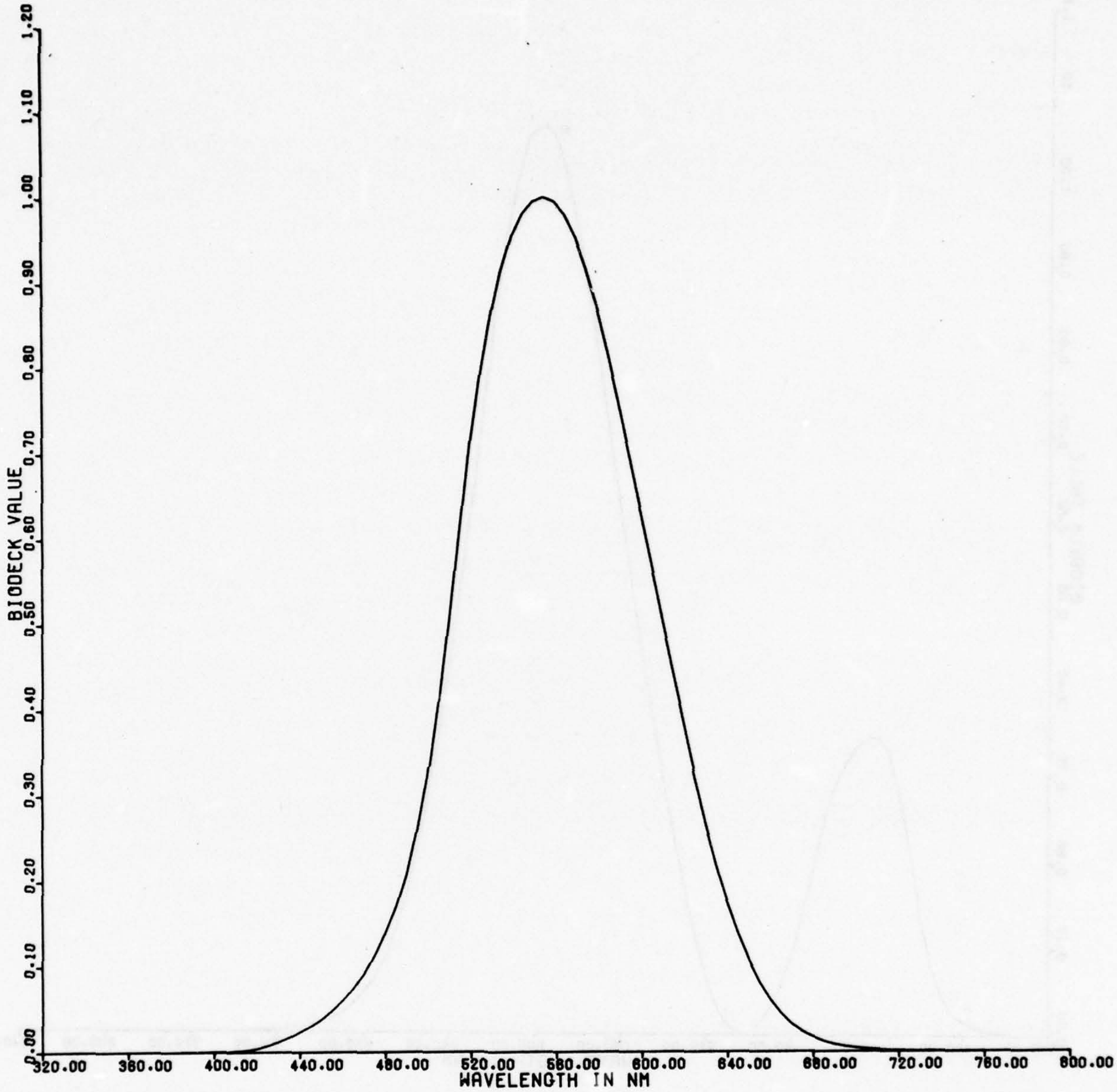

BIODECK VALUE
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
140.00
150.00
WAVELENGTH IN NM *10

BLUE HAZARD

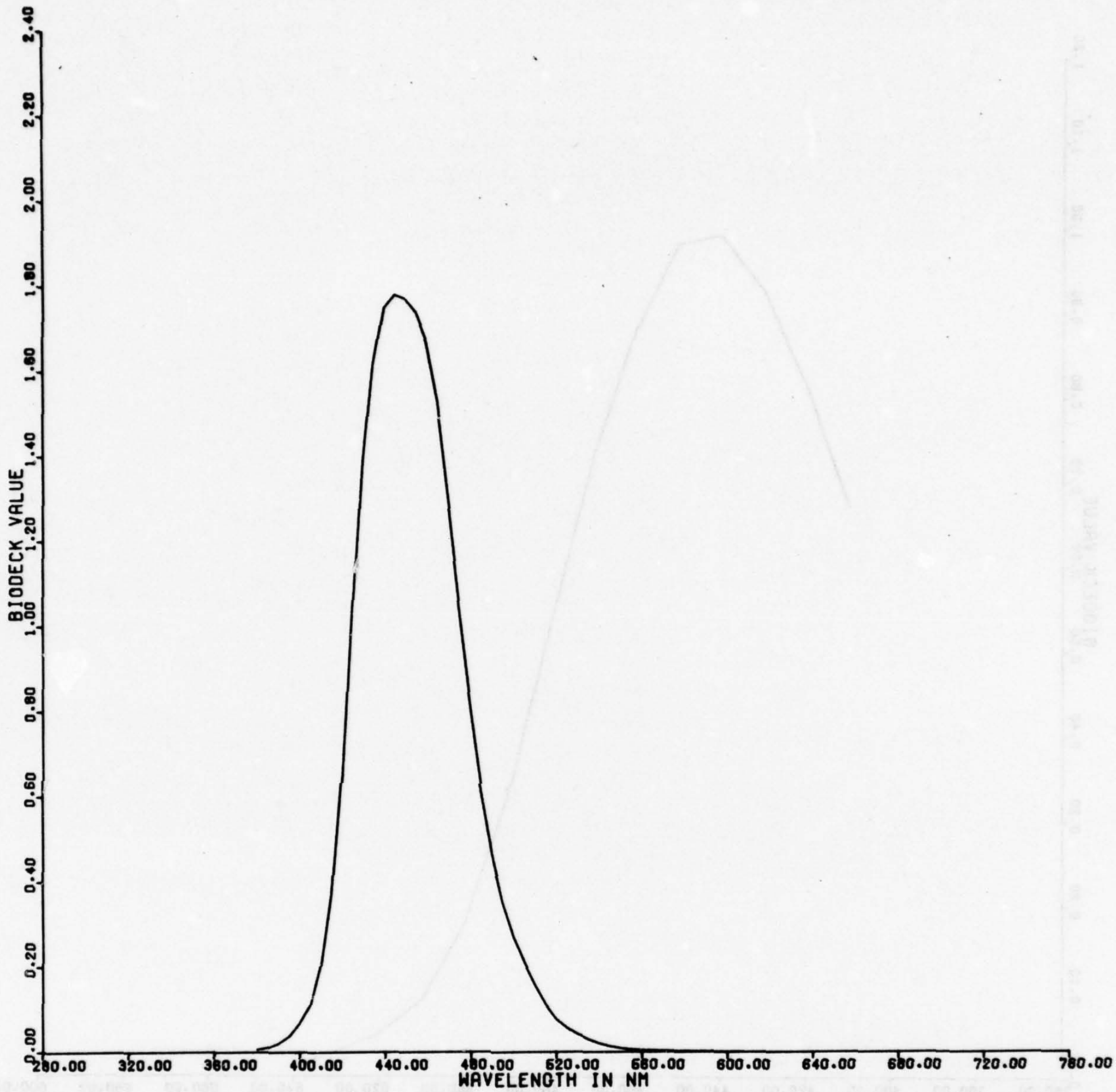


BIODECK VALUE
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
380.00
400.00
440.00
480.00
520.00
560.00
600.00
640.00
680.00
720.00
760.00
800.00
840.00
WAVELENGTH IN NM

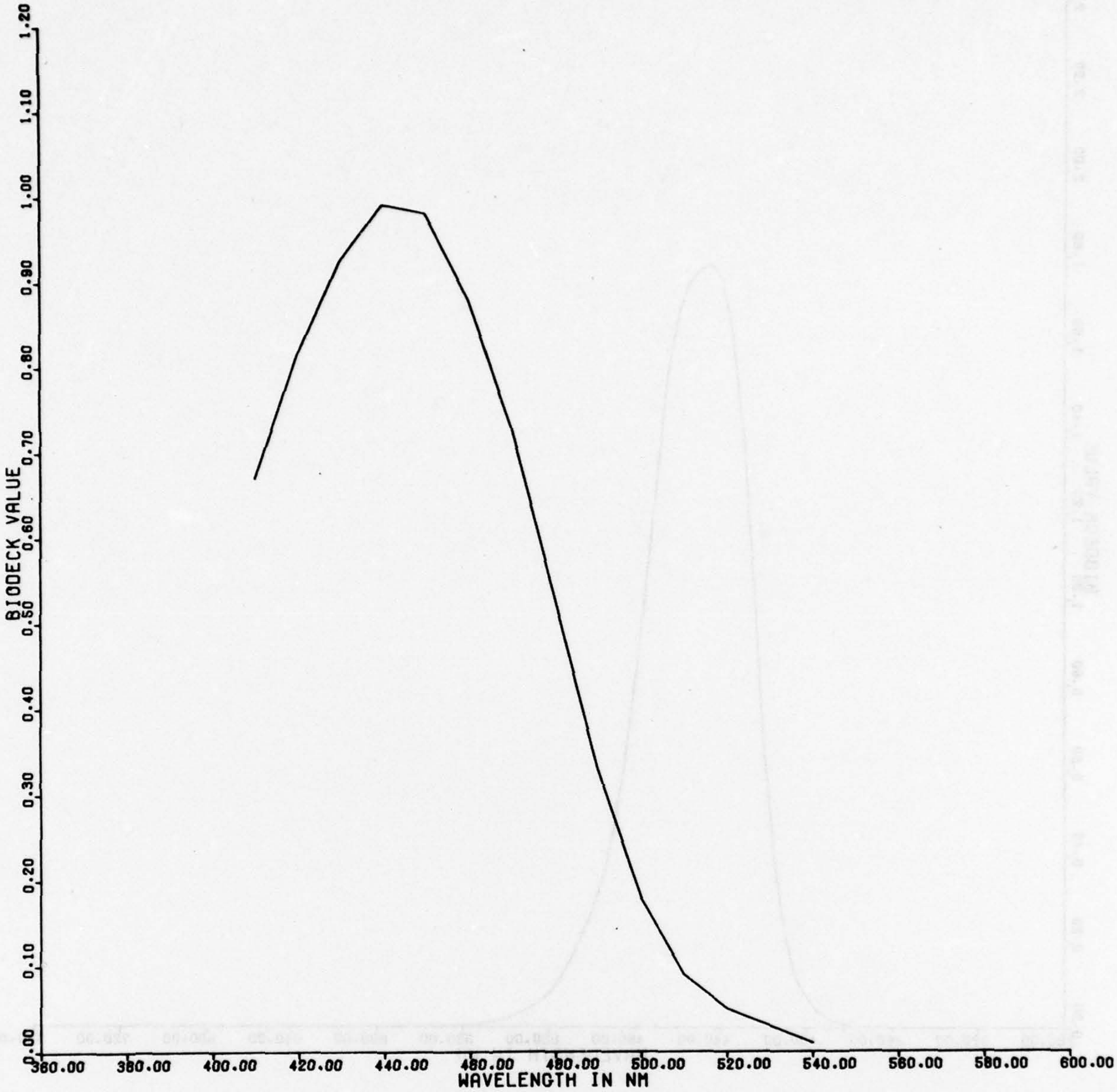
X-BAR DATA


BIODECK VALUE
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
320.00
360.00
400.00
440.00
480.00
520.00
560.00
600.00
640.00
680.00
720.00
760.00
800.00
WAVELENGTH IN NM

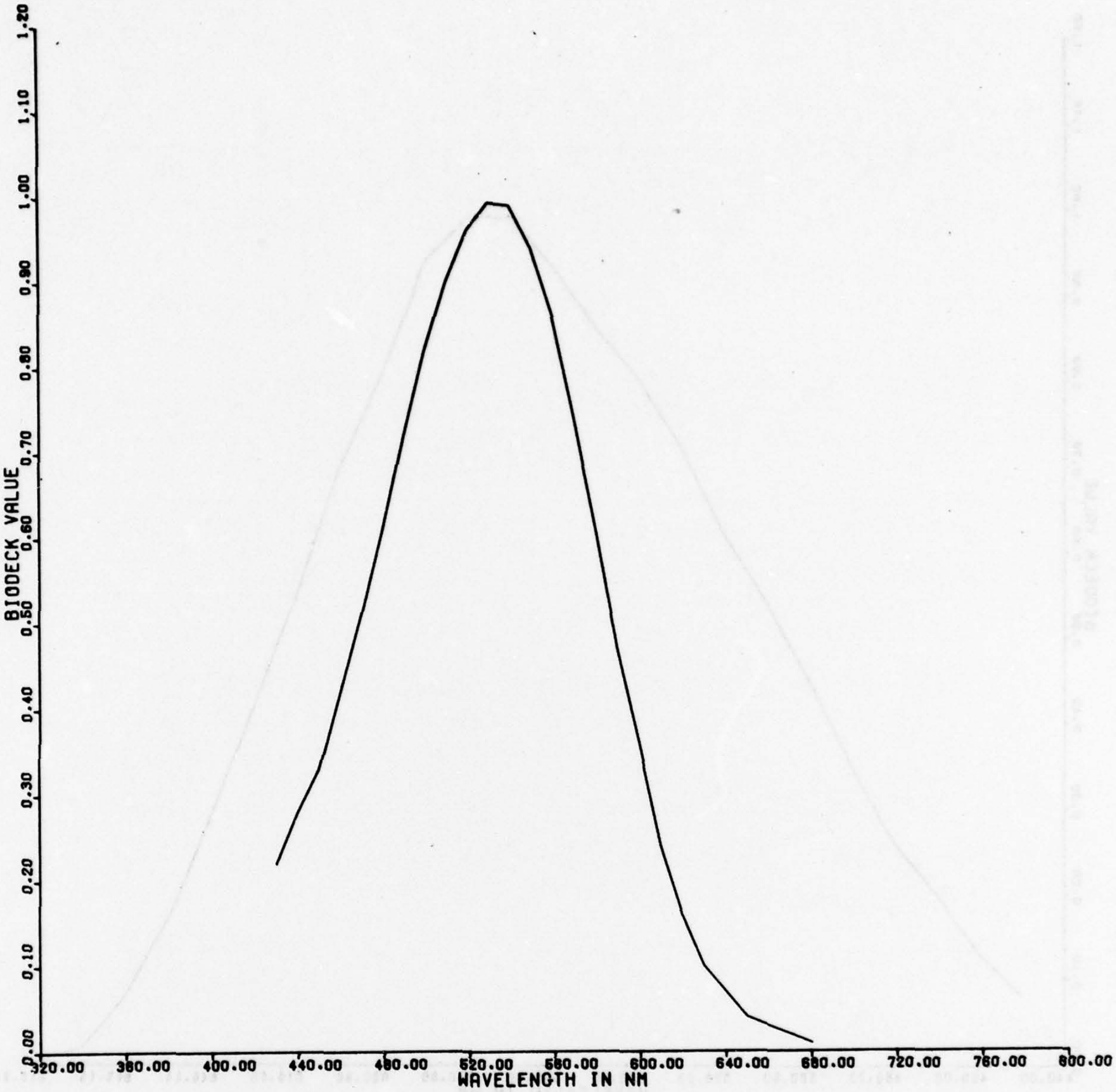
Y-BAR DATA


BIODECK VALUE
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
2.20
2.40
280.00
320.00
360.00
400.00
440.00
480.00
520.00
560.00
600.00
640.00
680.00
720.00
760.00
WAVELENGTH IN NM

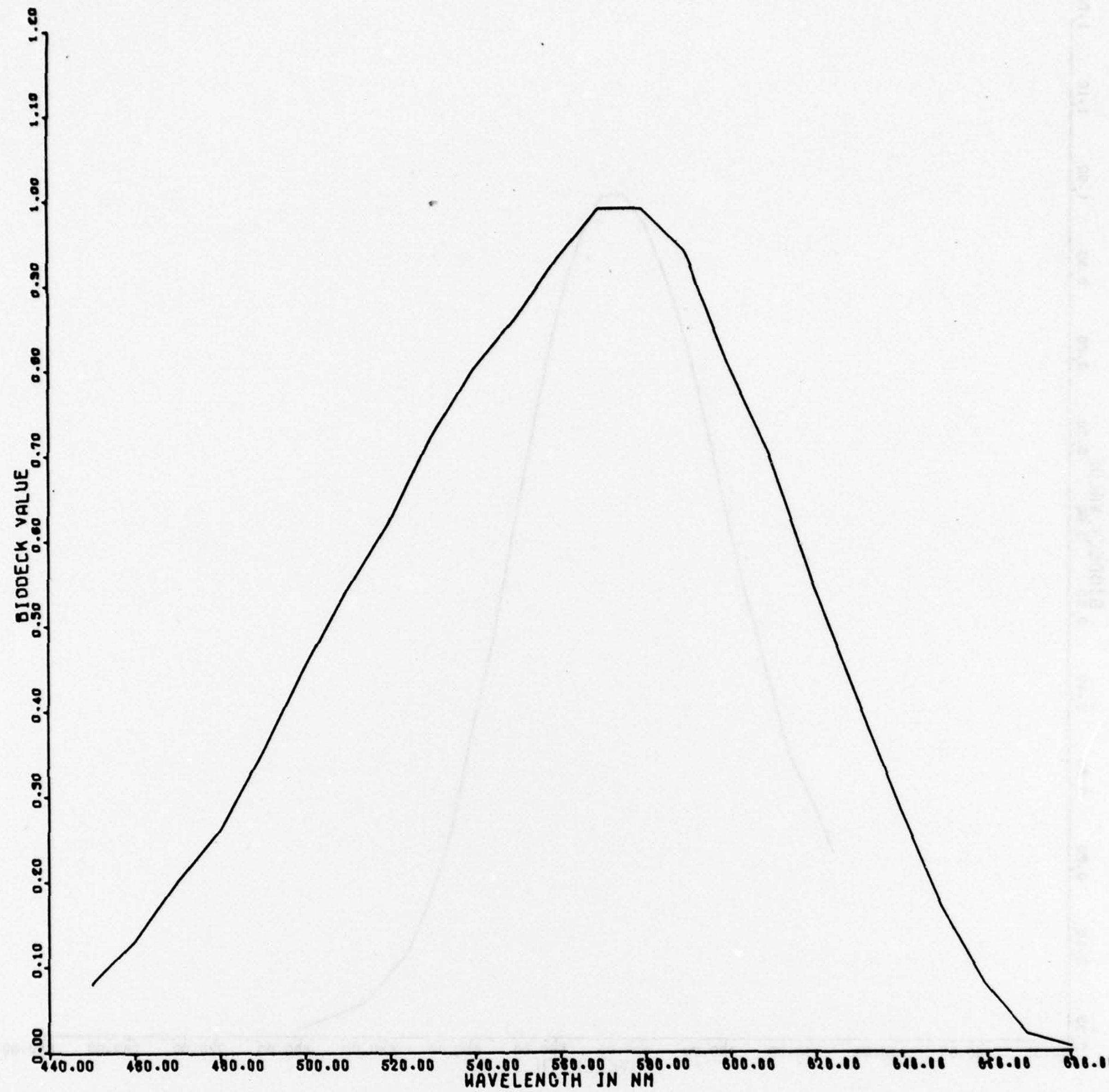
Z-BAR DATA


BIODECK VALUE
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
360.00
380.00
400.00
420.00
440.00
460.00
480.00
500.00
520.00
540.00
560.00
580.00
600.00
WAVELENGTH IN NM

P445 DATA


BIODECK VALUE
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
320.00
360.00
400.00
440.00
480.00
520.00
560.00
600.00
640.00
680.00
720.00
760.00
800.00
WAVELENGTH IN NM

P535 DATA



BIODECK VALUE
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
440.00
460.00
480.00
500.00
520.00
540.00
560.00
580.00
600.00
620.00
640.00
660.00
680.00
WAVELENGTH IN NM

P575 DATA

APPENDIX C

OPERATING INSTRUCTIONS

The following data will not change from run to run: S-, U-, A-, T-, T-A-, C-A-, V-, V*-, B-LAMBDA, X-BAR LAMBDA, Y-BAR LAMBDA, Z-BAR LAMBDA, P-445, P-535, and P-575. Other data vary with the run; the data decks must terminate with the proper END card and should be labeled on top. The run request must be checked to be certain that the data required by the calculation control card are supplied.

There must be two source description cards, even if one or both are blank.

The calcomp plot requires wide paper.

The same calculation and calibration data may be used for several sources. However, changing any calculation or calibration data during a run can be accomplished by using 'NEXT' as the event number on the event card. Control then branches to the beginning of the program, and expects two project description cards, etc, as if this were a different run request.

MESSAGES/HALTS

Messages
'CALIBRATION DATA NOT ENDED CORRECTLY'
'BIODECK DOES NOT HAVE AN END CARD'
'FILTER DATA WERE NOT ENDED CORRECTLY'
'GENERAL FUNCTION DOES NOT END CORRECTLY'
'SPECTRAL READINGS WERE NOT ENDED CORRECTLY'
Causes- No END card for data section. Or more than 340 cards in section.
Effect on program- Print error message and abort run.
Action- Insert END card at end of appropriate section; if END card is present, check spelling. Or remove extra cards. And rerun.

Message
'WAVE LENGTH XXXX OF SPECTRAL IRRADIANCE DOES NOT MATCH WAVE LENGTH OF READING FOR CALIBRATION FACTOR'
Cause- As in message.
Effect on program- Print error message and abort run.
Action- Correct errors on data cards and rerun.

Message
'DIVISION BY ZERO IN CALIBRATION FACTOR SECTION AT WAVE LENGTH XXXX'
Cause- Datum in second set of raw calibration data is zero.
Effect on program- Print error message and abort run.
Action- Correct error on data card and rerun.

Message
'CALIBRATION FACTOR ERROR-NUMBER RAW DATA NOT MATCHED'
Cause- Second set of raw calibration data has different number of items than first set.
Effect on program- Print error message and abort.
Action- Insert missing data and rerun.

Message
'ATTEMPT TO DIVIDE A CALIBRATION FACTOR OF ZERO INTO ADJUSTED INSTRUMENT READING AT WAVELENGTH XXXX'
Cause- First set of raw calibration data contains a zero.
Effect on program- Print error message and abort.
Action- Change zero to valid value and rerun.

Message
'ALL PROCESSING COMPLETED'
Cause- Normal completion of program.
Effect on program- Normal completion.
Action- None required.

INSTRUCTIONS FOR FILLING OUT FORMS

The data for the LMD Spectral Weighting Program must be entered on a number of coding forms in order to input the information to the computer. Explicit instructions for filling out each form are provided below:

A. Cover Sheet. These data are used to identify the information for future reference and determine the kinds of input data to the Data Processing personnel. Item-by-item instructions are given below.

1. Project Number. Fill in local project number which will identify the spectral source or filter.

2. Source Description. Briefly give source description and/or project name (20 words or less). Adequately describe source for future reference.

3. Calibration Deck Used. List number of calibration deck. This deck may be on file with the computer center or the calibration factors may be submitted with the rest of the forms.

4. Calculation Control Card. Enter code number in each box which describes the kinds of data which will be run. Two filters with known spectral characteristics may be submitted with the source data if desired. Normally, instrument readings are submitted which permit the computer to calculate the spectral irradiance, E_λ, by dividing the reading by the calibration factor; however, spectral irradiance values may be the direct input without a calibration factor if desired. One specific biologic function weighted against the source spectrum may be listed spectrally if desired. One of the following codes should be inserted in columns 4 and 5 of this card to specify this function.

00 -- None
01 -- S_λ -- Ultraviolet Irradiance According to ACGIH Action Spectra
02 -- U_λ -- Ultraviolet Irradiance According to CIE Action Spectra
03 -- A_λ -- Ultraviolet Irradiance According to ANSI Action Spectra
04 -- T -- Transmission of the Ocular Media x E_λ
05 -- T·A -- Transmission of the Ocular Media x Absorption of Retina x E_λ
06 -- $1/C_A$ -- Reciprocal of ANSI MPE Weighting Factor
07 -- V_λ -- Photopic Spectral Luminous Efficiency x E_λ
08 -- V_λ' -- Scotopic Spectral Luminous Efficiency x E_λ
09 -- B_λ -- Blue Light Hazard Function x E_λ
10 -- $\overline{X}_\lambda$ -- Spectral Tristimulus value (red) x E_λ
11 -- $\overline{Y}_\lambda$ -- Spectral Tristimulus value (green) x E_λ
12 -- $\overline{Z}_\lambda$ -- Spectral Tristimulus value (blue) x E_λ
13 -- P_{445} -- Dartnall Nomogram Absorption Coefficient for Blue x E_λ
14 -- P_{535} -- Dartnall Nomogram Absorption Coefficient for Green x E_λ
15 -- P_{575} -- Dartnall Nomogram Absorption Coefficient for Red x E_λ

5. Number of Data Decks Submitted. Enter the number of individual source spectrums which are being submitted at this time under this cover sheet.

6. Check List. Be sure all listed information is submitted either on or with the cover sheet.

B. Source Data Sheet. This form is the first form used for recording spectral data by wavelength -- Instrument reading from a particular instrument. All three items on this form must be filled in.

1. Source Name. The source name is used to distinguish between several source spectrums entered under the same cover sheet. This name should be kept under 8 characters if possible.

2. Source Solid Angle. The Solid Angle of the source must be entered in exponential notation (example, 1.00E-05). If the solid angle is not known, an approximation must be used.

3. Data Values. Values are entered in integer form for wavelength and exponential form for instrument reading. The wavelength values must be placed in the rightmost columns (235, not 235). Spectral peaks may be identified to the right of the instrument readings by inserting the word "PEAK" in the indicated columns. These values are then treated separately by the computer program.

C. Calibration-Filter Sheet. This form may be used for calibration or for filter information. Information should be placed in the first two columns by wavelength and value. The type of coded information should be identified at the top of the form.

D. Data Continuation Sheet. This form may be used for continuation of either source data or calibration values.

E. End Card. At the end of either the source data deck or at the end of the calibration deck, the statement "END of Spectral Data" or "END of Calibration Deck" must be inserted.

EXPANDED PROGRAM USE

Some additional features are built into the program. However their use is not recommended for general use. Key personnel may be required to assemble the run stream and thereby increase the processing time. Some of these features are listed below.

A. Distance Factors. These two factors may be used to adjust calibration values for variations in the distance from a standard lamp that a piece of equipment was placed for calibration. For instance, if the required measurement distance was 50 cm and the calibration was made at 100 cm, a distance factor of 4.0 could be inserted into the program. However, the READ statement was deleted from the program which read in these values. These two factors are designated DFU and DFV and are applied to the UV portion of the spectrum and the visible and near-IR portion respectively.

B. Uncomputed Calibration Deck. The calibration values may be submitted in two decks rather than one. The program will then divide the instrument readings (first deck) by the spectrum of the standard lamp (second deck). If data are submitted in this form, a zero is placed in column 3 of the Calculation Control Card.

C. Uncomputed Filter Data. Filter data may be submitted in two columns rather than one following the wavelength values. The second column is then divided by the first. Enter a "2" in column 2 of the Calculation Control Card to run the program this way.

D. General Function. Part of the source data may be corrected if found faulty after the cards have been punched. The deck may be corrected throughout certain wavelength regions by the use of this function. The starting wavelength, the ending wavelength, and the correction factor are coded on the special form provided. As many correction cards as needed may be used. An "END" card must be placed at the end of this function.

E. Expanded Run Stream. The order of the various inputs is listed below.

1. Source Description (two cards)
2. Calculation Control Card
3. Distance Factors (program change required)
4. Calibration Deck
5. Standard Lamp Data (if required)
6. BIO Deck
7. Filter Transmissions
8. General Function
9. Source Name (Event)
10. Source Solid Angle
11. Source Data Readings

LASER MICROWAVE DIVISION SPECTRAL WEIGHTING PROGRAM

COVER SHEET

A. PROJECT NUMBER: 42- ________.

B. SOURCE DESCRIPTION: ______________________________

(free format, 158 spaces) ______________________________

____

C. CALIBRATION DECK USED: DECK NUMBER ________.

☐ ON FILE ☐ INCLUDED WITH DATA DECK

D. CALCULATION CONTROL CARD:

	1	2	3	4	5
BOX NUMBER:					

1. Number of Filters to be Processed -- Enter Number (maximum is two)

2. Leave Blank

3. Form of Calibration Deck:

   a. Regular -- Enter "1"

   b. None Required -- Enter "2"

4-5. Specific Biologic Function to be Listed Spectrally -- Enter code

a. None -- 00	e. T -- 04	i. V_λ' -- 08	m. $\bar{Z}_\lambda$ -- 12
b. S_λ -- 01	f. T·A -- 05	j. B_λ -- 09	n. P_{445} -- 13
c. U_λ -- 02	g. $1/C_A$ -- 06	k. $\bar{X}_\lambda$ -- 10	o. P_{535} -- 14
d. A_λ -- 03	h. V_λ -- 07	l. $\bar{Y}_\lambda$ -- 11	p. P_{575} -- 15

E. NUMBER OF DATA DECKS SUBMITTED: ________.

F. CHECK LIST: ☐ Source Description ☐ Instrument Readings

(✓) ☐ Calculation Control Card ☐ Solid Angle

☐ Calibration Deck

SOURCE DATA SHEET

Line 1) Source Name

Line 2) Source Solid Angle

Line 3) Event Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
					E	–											

Identification					
75	76	77	78	79	80

Wave Length												Peak ID			
1	2	3	4	10	11	12	13	14	15	16	17	20	21	22	23
								E	–						

Identification					
75	76	77	78	79	80

USES: Calibration
Lamp
Pre-Computed Calibration
Bio Information
Filter Data

Wave Length																				Ident					
1	2	3	4	10	11	12	13	14	15	16	17	19	20	21	22	23	24	25	26	75	76	77	78	79	80
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SOURCE DATA CONTINUATION SHEET
USES: Source Data

Wave Length												Peak ID				Identification					
1	2	3	4	10	11	12	13	14	15	16	17	20	21	22	23	75	76	77	78	79	80

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USES: General Function

Starting Wave Length				Ending Wave Length				Correction Factor								Identification					
1	2	3	4	10	11	12	13	21	22	23	24	25	26	27	28	75	76	77	78	79	80
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APPENDIX D

USEFUL CIE RADIOMETRIC AND PHOTOMETRIC TERMS AND UNITS[1,2]

RADIOMETRIC				PHOTOMETRIC			
Term	**Symbol**	**Defining Equation**	**SI Unit and Abbreviation**	**Term**	**Symbol**	**Defining Equation**	**SI Units and Abbreviation**
Radiant Energy	Q_e		Joule (J)	Quantity of Light	Q_v	$Q_v = \int \Phi_v dt$	lumen-second (lm·s) (talbot)
Radiant Energy Density	W_e	$W_e = \frac{dQ_e}{dV}$	Joule per cubic meter (J·m^{-3})	Luminous Energy Density	W_v	$W_v = \frac{dQ_v}{dV}$	talbot per square meter (lm·s·m^{-3})
Radiant Power (Radiant Flux)	Φ_e, P	$\Phi_e = \frac{dQ_e}{dt}$	Watt (W)	Luminous Flux	Φ_v	$\Phi_v = 680 \int \frac{d\Phi_e}{d\lambda} V(\lambda)\, d\lambda$	lumen (lm)
Radiant Exitance	M_e	$M_e = \frac{d\Phi_e}{dA} = \int L_e \cdot \cos\theta \cdot d\Omega$	Watt per square meter (W·m^{-2})	Luminous Exitance	M_v	$M_v = \frac{d\Phi_v}{dA} = \int L_v \cdot \cos\theta \cdot d\Omega$	lumen per square meter lm·m^{-2}
Irradiance or Radiant Flux Density (Dose Rate in Photobiology)	E_e	$E_e = \frac{d\Phi_e}{dA}$	Watt per square meter (W·m^{-2})	Illuminance (luminous flux density)	E_v	$E_v = \frac{d\Phi_v}{dA}$	lumen per square meter (lm·m^{-2}) lux (lx)
Radiant Intensity	I_e	$I_e = \frac{d\Phi_e}{d\Omega}$	Watt per steradian (W·sr^{-1})	Luminous Intensity (candlepower)	I_v	$I_v = \frac{d\Phi_v}{dr}$	lumen per steradian (lm·sr) or candela (cd)
Radiance	L_e	$L_e = \frac{d^2\Phi_e}{d\Omega \cdot dA \cdot \cos\theta}$ [5]	Watt per steradian and per square meter (W·sr^{-1}·m^{-2})	Luminance	L_v	$L_v = \frac{d^2\Phi_e}{dr \cdot dA \cdot \cos\theta}$ [5]	candela per square meter (cd·m^{-1})
Radiant Exposure (Dose, in Photobiology)	H_e	$H_e = \frac{dQ_e}{dA}$	Joule per square meter (J·m^{-2})	Light Exposure	H_v	$H_v = \frac{dQ_v}{dA} = \int E_v dt$	lux-second (lx·s)
				Luminous Efficacy (of radiation)	K	$K = \frac{\Phi_v}{\Phi_e}$	lumen per watt (lm·W^{-1})
				Luminous Efficiency (of a broad band radiation)	V(*)	$V(*) = \frac{K}{K_m} = \frac{K}{680}$	unitless
Radiant Efficiency [3] (of a source)	η_e	$\eta_e = \frac{P}{P_i}$	unitless	Luminous Efficacy[3] (of a source)	η_v	$\eta_v = \frac{\Phi_v}{P_i}$	lumen per watt (lm·W^{-1})
Optical Density [4]	D_e	$D_e = -\log_{10} \tau_e$	unitless	Optical Density[4]	D_v	$D_v = -\log_{10} \tau_v$	unitless
				Retinal Illuminance in Trolands	E_t	$E_t = \frac{L_v}{S_p}$	troland (td) = luminance in cd·m^{-2} times pupil area in mm^2

1. The units may be altered to refer to narrow spectral bands in which case the term is preceded by the word *spectral*, and the unit is then per wavelength interval and the symbol has a subscript λ. For example, spectral irradiance H_λ has units of W·m^{-2}·m^{-1} or more often, W·cm^{-2}·nm^{-1}.
2. While the meter is the preferred unit of length, the centimeter is still the most commonly used unit of length for many of the above terms and the nm or µm are most commonly used to express wavelength.
3. P_i is electrical input power in watts.
4. τ is the transmission
5. At the source $L = \frac{dI}{dA \cdot \cos\theta}$ and at a receptor $L = \frac{dE}{d\Omega}$

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